H·REII Heat Recovery in Energy Intensive Industries

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Code	Sector
B	**EXTRACTION OF MINERALS FROM QUARRY AND MINING**
05	**COAL MINING (EXCLUDED PEAT)**
05.1	**ANTHRACITE MINING**
05.10	**Anthracite mining**
05.10.0	Coal and anthracite mining
05.10.00	Coal and anthracite mining
05.2	**LIGNITE MINING**
05.20	**Lignite mining**
05.20.0	Lignite mining
05.20.00	Lignite mining
06	**EXTRACTION OF CRUDE OIL AND NATURAL GAS**
06.1	**CRUDE OIL EXTRACTION**
06.10	**Crude oil extraction**
06.10.0	Crude oil extraction
06.10.00	Crude oil extraction
06.2	**NATURAL GAS EXTRACTION**
06.20	**Natural gas extraction**
06.20.0	Natural gas extraction
06.20.00	Natural gas extraction
C	**MANUFACTURING**
10	**FOOD INDUSTRY**
10.4	**PRODUCTION OF ANIMAL AND VEGETABLE GREASES AND OILS**
10.41	**PRODUCTION OF GREASES AND OILS**
10.41.1	Production of olive oil from olives prevalently not own produced
10.41.10	Production of olive oil from olives prevalently not own produced
10.41.2	Production of crude or refined oil from oilseeds or oleaginous fruits prevalently not own produced
10.41.20	Production of crude or refined oil from oilseeds or oleaginous fruits prevalently not own produced
10.41.3	Production of crude or refined animal greases and oils
10.41.30	Production of crude or refined animal greases and oils
10.42	**Manufacture of margarine and similar edible greases**
10.42.0	Manufacture of margarine and similar edible greases
10.42.00	Manufacture of margarine and similar edible greases
10.8	**PRODUCTION OF OTHER ALIMENTARY PRODUCTS**
10.81	**Sugar production**
10.81.0	Sugar production
10.81.00	Sugar production
11	**BEVERAGE INDUSTRY**
11.0	**BEVERAGE INDUSTRY**
11.01	**Distilling, rectifying and blending spirits**
11.01.0	Distilling, rectifying and blending spirits

11.01.00	Distilling, rectifying and blending spirits
11.05	**Beer production**
11.05.0	Beer production
11.05.00	Beer production
16	**INDUSTRY OF WOOD AND OF WOOD AND CORK PRODUCTS (EXCEPT FORNITURE); MANUFACTURE OF ARTICLES OF STRAW AND PLAITING MATERIALS**
16.1	**CUTTING AND PLANING OF WOOD**
16.10	**Cutting and planing of wood**
16.10.0	Cutting and planing of wood
16.10.00	Cutting and planing of wood
16.2	**MANUFACTURE OF PRODUCTS BY WOOD, CORK, STRAW AND PLAITING MATERIALS**
16.21	**Manufacture of veneer sheet and of wood based panels**
16.21.0	Manufacture of veneer sheet and of wood based panels
16.21.00	Manufacture of veneer sheet and of wood based panels
16.22	**Production of parquet assembled floors**
16.22.0	Production of parquet assembled floors
16.22.00	Production of parquet assembled floors
16.23	**Manufacture of other wood products for carpentry and building joinery**
16.23.1	Production of wood doors and windows (Excluding armoured doors)
16.23.10	Production of wood doors and windows (Excluding armoured doors)
16.23.2	Manufacture of other wood elements and building joinery
16.23.20	Manufacture of other wood elements and building joinery
19	**MANUFACTURE OF COKE AND OF PETROLEUM PRODUCTS DERIVING FROM REFINING CRUDE OIL**
19.1	**MANUFACTURE OF COKE OVEN PRODUCTS**
19.10	**Manufacture of coke oven products**
19.10.0	Manufacture of coke oven products
19.10.01	Manufacture of pitch and coke pitch
19.10.09	Manufacture of other coke oven products
19.2	**MANUFACTURE OF PETROLEUM PRODUCTS DERIVING FROM REFINING CRUDE OIL**
19.20	**Manufacture of petroleum products deriving from refining crude oil**
19.20.1	Petroleum refineries
19.20.10	Petroleum refineries
19.20.2	Preparation or mixing of petroleum products (excluding petrochemicals)
19.20.20	Preparation or mixing of petroleum products (excluding petrochemicals)
19.20.4	Manufacture of bitumen and tar emulsions and of binders for street use
19.20.40	Manufacture of bitumen and tar emulsions and of binders for street use
19.20.9	Manufacture of other petroleum refining products

19.20.90	Manufacture of other petroleum refining products
20	**MANUFACTURE OF CHEMICAL PRODUCTS**
20.1	**MANUFACTURE OF BASIC CHEMICAL PRODUCTS, OF FERTILIZERS AND NITROGENOUS COMPOUNDS, OF PLASTIC AND SYNTHETIC RUBBER IN PRIMARY FORM**
20.11	**Manufacture of industrial gases**
20.11.0	Manufacture of industrial gases
20.11.00	Manufacture of industrial gases
20.12	**Manufacture of dyes and pigments**
20.12.0	Manufacture of dyes and pigments
20.12.00	Manufacture of dyes and pigments
20.13	**Manufacture of other inorganic chemical products**
20.13.0	Manufacture of others inorganic chemical products
20.13.01	Manufacture of enriched uranium and thorium
20.13.09	Manufacture of others inorganic chemical products
20.14	**Manufacture of others organic chemical products**
20.14.0	Manufacture of others organic chemical products
20.14.01	Manufacture of ethyl alcohol and of fermented materials
20.14.09	Manufacture of others organic chemical products nca
20.15	**Manufacture of fertilizers and nitrogenous compounds**
20.16	**Manufacture of plastic materials in primary form**
20.17	**Manufacture of synthetic rubber in primary form**
20.17.0	Manufacture of synthetic rubber in primary form
20.17.00	Manufacture of synthetic rubber in primary form
20.3	**MANUFACTURE OF PAINTS, LACQUERS AND ENAMELS. MANUFACTURE OF PRINTING INKS AND MASTICS**
20.6	**MANUFACTURE OF SYNTHETIC AND ARTIFICIAL FIBRES**
20.60	**Manufacture of synthetic and artificial fibres**
20.60.0	Manufacture of synthetic and artificial fibres
20.60.00	Manufacture of synthetic and artificial fibres
23	**MANUFACTURE OF OTHER PRODUCTS FROM WORKING OF NON-METALLIC MINERALS**
23.1	**MANUFACTURE OF GLASS AND GLASS PRODUCTS**
23.11	**Manufacture of flat glass**
23.11.0	Manufacture of flat glass
23.11.00	Manufacture of flat glass
23.12	**Work and transformation of flat glass**
23.12.0	Work and transformation of flat glass
23.12.00	Working and transformation of flat glass
23.13	**Manufacture of hollow glass**
23.13.0	Manufacture of hollow glass
23.13.00	Manufacture of hollow glass
23.14	**Manufacture of fibreglass**
23.14.0	Manufacture of fibreglass
23.14.00	Manufacture of fibreglass

23.19	**Manufacture and working of other glass (included glass for technical uses), working of hollow glass**
23.19.1	Manufacture of glassware for laboratory, for hygienic uses and for pharmaceutical
23.19.10	Manufacture of glassware for laboratory, for hygienic uses and for pharmaceutical
23.19.2	Handwork glass and blown glass
23.19.20	Handwork glass and blown glass
23.19.9	Manufacture of others glass products (included technical glassware)
23.19.90	Manufacture of others glass products (included technical glassware)
23.2	**MANUFACTURE OF REFRACTORY PRODUCTS**
23.20	**Manufacture of refractory products**
23.20.0	Manufacture of refractory products
23.20.00	Manufacture of refractory products
23.32	**Manufacture of bricks, tiles and other construction products in baked clay**
23.32.0	Manufacture of bricks, tiles and other construction products in baked clay
23.32.00	Manufacture of bricks, tiles and other construction products in baked clay
23.5	**MANUFACTURE OF CEMENT, LIME AND PLASTER**
23.51	**Manufacture of cement**
23.51.0	Manufacture of cement
23.51.00	Manufacture of cement
23.52	**Manufacture of lime and plaster**
23.52.1	Manufacture of lime
23.52.10	Manufacture of lime
23.52.2	Manufacture of plaster
23.52.20	Manufacture of plaster
23.6	**MANUFACTURE OF CONCRETE, CEMENT AND PLASTER PRODUCTS**
23.61	**Manufacture of concrete products for building**
23.61.0	Manufacture of concrete products for building
23.61.00	Manufacture of concrete products for building
23.62	**Manufacture of plaster products for building**
23.62.0	Manufacture of plaster products for building
23.62.00	Manufacture of plaster products for building
23.63	**Manufacture of concrete ready for the use**
23.63.0	Manufacture of concrete ready for the use
23.63.00	Manufacture of concrete ready for the use
23.64	**Manufacture of mortar**
23.64.0	Manufacture of mortar
23.64.00	Manufacture of mortar
23.65	**Manufacture of fibrecement products**
23.65.0	Manufacture of fibrecement products
23.65.00	Manufacture of fibrecement products
23.69	**Manufacture of others concrete, plaster and cement products**

23.69.0	Manufacture of others concrete, plaster and cement products
23.69.00	Manufacture of others concrete, plaster and cement products
24	**METALLURGY**
24.1	**STEEL INDUSTRY**
24.10	**Steel industry**
24.10.0	Steel industry – Manufacture of iron, steel and ferroalloys
24.10.00	Steel industry – Manufacture of iron, steel and ferroalloys
24.2	**MANUFACTURE OF STEEL PIPE, TUBES, HOLLOW PROFILES AND RELATED ACCESSORIES (EXCEPT THOSE IN CAST STEEL)**
24.20	**Manufacture of steel pipe, tubes, hollow profiles and related accessories (except those in cast steel)**
24.20.1	Manufacture of tubes and pipes without welding
24.20.10	Manufacture of tubes and pipes without welding
24.20.2	Manufacture of welded pipes and tubes and similar
24.20.20	Manufacture of welded pipes and tubes and similar
24.3	**MANUFACTURE OF OTHERS PRODUCTS OF PRIMARY STEEL PROCESSING**
24.31	**Cold drawing of bars**
24.31.0	Cold drawing of bars
24.31.00	Cold drawing of bars
24.32	**Cold rolling of strip**
24.32.0	Cold rolling of strip
24.32.00	Cold rolling of strip
24.4	**MANUFACTURE OF BASIC PRECIOUS METALS AND OTHER NON-FERROUS METALS; PROCESSING OF NUCLEAR FUEL**
24.41	**Manufacture of precious metal**
24.41.0	Manufacture of precious metal and semi-finished products
24.41.00	Manufacture of precious metal and semi-finished products
24.42	**Manufacture of aluminium**
24.42.0	Manufacture of aluminium and semi-finished products
24.42.00	Manufacture of aluminium and semi-finished products
24.43	**Manufacture of lead, zinc and tin and semi-finished products**
24.43.0	Manufacture of lead, zinc and tin and semi
24.43.00	Manufacture of lead, zinc and tin and semi
24.44	**Manufacture of copper**
24.44.0	Manufacture of copper and semi-finished products
24.44.00	Manufacture of copper and semi-finished products
24.45	**Manufacture of others non-metallic products**
24.45.0	Manufacture of others non-metallic products and semi-finished products
24.45.00	Manufacture of others non-metallic products and semi-finished products
24.5	**FOUNDRIES**
24.51	**Cast iron**
24.51.0	Casting of iron and production of cast iron pipes and fittings
24.51.00	Casting of iron and production of cast iron pipes and fittings

24.52	**Steel casting**
24.52.0	Steel casting
24.52.00	Steel casting
24.53	**Casting of light metal**
24.53.0	Casting of light metal
24.53.00	Casting of light metal
24.54	**Casting of others non-iron metal**
24.54.0	Casting of others non-iron metal
24.54.00	Casting of others non-iron metal
31	**MANUFACTURE OF FURNITURES**
31.0	**MANUFACTURE OF FURNITURES**
31.01	**Manufacture of furnitures for offices and shops**
31.01.1	Manufacture of chairs and armchairs for offices and shops
31.01.10	Manufacture of chairs and armchairs for offices and shops
31.01.2	Manufacture of others furnitures for offices and shops
31.01.21	Manufacture of others furnitures for offices and shops
31.01.22	Manufacture of others non-metallic furnitures for offices and shops
31.02	**Manufacture of furnitures for kitchen**
31.02.0	Manufacture of furnitures for kitchen
31.02.00	Manufacture of furnitures for kitchen
31.09	**Manufacture of others furnitures**
31.09.1	Manufacture of furnitures for home
31.09.10	Manufacture of furnitures for home
31.09.2	Manufacture of chairs and seats (except for aircraft, vehicles, ships, trains, offices and shops)
31.09.20	Manufacture of chairs and seats (except for aircraft, vehicles, ships, trains, offices and shops)
31.09.3	Manufacture of armchairs and sofas
31.09.30	Manufacture of armchairs and sofas
31.09.4	Manufacture of parts and accessories of furnitures
31.09.40	Manufacture of parts and accessories of furnitures
31.09.5	Refinishing furniture
31.09.50	Refinishing furniture
31.09.9	Manufacture of others furnitures (including those for outdoor furniture)
31.09.90	Manufacture of others furnitures (including those for outdoor furniture)
D	**SUPPLY OF ELECTRICITY, GAS, STEAM AND AIR CONDITIONING**
35	**SUPPLY OF ELECTRICITY, GAS, STEAM AND AIR CONDITIONING**
35.1	**PRODUCTION, TRASMISSION AND DISTRIBUTION OF ELECTRICITY**
35.11	**Production of electricity**
35.11.0	Production of electricity
35.11.00	Production of electricity

35.2	**GAS PRODUCTION; DISTRIBUTION OF GASEOUS FUELS THROUGH MAINS**
35.22	**Distribution of gaseous fuels through mains**
35.22.0	Distribution of gaseous fuels through mains
35.22.00	Distribution of gaseous fuels through mains
E	**WATER SUPPLY; SEWERAGE, ACTIVITIES OF WASTE MANAGEMENT AND RESTORATION**
38	**WATER SUPPLY; SEWERAGE, ACTIVITIES OF WASTE MANAGEMENT AND RESTORATION**
38.2	**TREATMENT AND DISPOSAL OF WASTE**
38.21	**Treatment and disposal of non-dangerous waste**
38.21.0	Treatment and disposal of non-dangerous waste; compost production
38.21.01	Compost production
38.21.09	Treatment and disposal of others non-dangerous waste

DESCRIPTION OF ENERGY INTENSIVE SECTORS

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COAL MINING (EXCLUDED PEAT) [ATECO 05]

Methane is produced from underground mines and surface, and as a result of post-mining activities including processing, transport and storage of coal. Underground mines are the largest source of methane emissions from mines (CMM) in most countries.

Overall, the CMM represents 8% of total emissions of methane from human activities. In 2000, global emissions of CMM amounted to 120 million metric tons carbon equivalent (MMTCE), or about 30,8 billions cubic meters (BCM).

Methane in underground mines must be removed for safety reasons. This is done through large-scale ventilation systems, which handle large volumes of air through the mines. These ventilation systems keep mines safe, but also release large quantities of methane in very low concentrations. In some active and abandoned mines, methane is produced from degasification systems (also known as gas drainage systems) using vertical and / or horizontal wells for methane recovery.

There are a variety of valid uses of CMM, and the optimal use in a given location depends on several factors, such as quality of methane, the availability of different options for use and cost of projects. The scope of CMM projects includes the injection gas pipeline, **electricity generation**, combustion in boilers, district heating, mine heating, coal drying, food vehicles, flaring and other industrial / manufacturing uses such as food for the production of carbon black, methanol and dimethyl ether. **Because of very low concentration methane in mine ventilation, technological development has progressed to the point where this source of CMM can be oxidized and the resulting heat can be used to produce heat, electricity and refrigeration**. *The Jincheng Anthracite Mining Group, Inc., located in Shanxi province, China, manufacturer of high quality anthracite has installed two CMM-fired power stations with total capacity of about 6 MW.*

Sources:

- www.methanetomarkets.org

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FOOD INDUSTRY [ATECO 10]

ATECO 10.41 PRODUCTION OF GREASES AND OILS

COLZA OIL AND SUNFLOWERS COMBUSTION: An average of 18 quintals of seeds and of 6.3 quintals of oil is produced per every hectare of sunflowers field, while an average of 18 quintals of seeds and 5.04 quintals of oils is produced per hectare of rapes field. These oils are burned to produce electricity by means of internal combustion engines from marine application in power stations. The flue gases may be sent either to boilers for producing steam at low pressure or to low pressure steam turbines. As the operative temperature range for the fumes abatement varies between 180°C and 350°C these fumes can be reused for electricity production by means of an ORC plant.

Sources:
- Centrale S.E.C.A. Campo all'Olmo.

ATECO 10.8 PRODUCTION OF OTHER ALIMENTARY PRODUCTS

PRODUCTION OF YEAST: During the production of yeast, biogas with high concentration of methane (about 88%) is recovered from a by-product. Medium to large plants are already equipped with gas turbine + recovery boiler and steam turbine inasmuch the production process requires steam at medium/low temperatures. A cogeneration system is located in a plant for yeast production. The plant consumes electricity for 18GWh/year and methane gas for 5.500.55 m3/year (total expenditure: € 2.6 Million / year). A 2MW gas alternative cogeneration unit has been installed. The investment of 2.187.00 € will do save primary energy for 1600 tep per year.

Sources:
- www.poloenrgia.com
- http://www.leonardo-energy.org/energy-efficiency-food-beverage-industry

All the productive sectors that require cooking and sterilization of containers can be evaluated. Even if the required temperatures are not interesting, it can be considered to install a cogeneration plant if the related power is high enough. The processes depend obviously from the food products that may require a set of the following phases: washing, cooking, wrapping, freezing. The heat recovery process can be applied to wastewater of washing and rinsing cycles, to exhaust gases of dryers and steam boilers, to the condensation of the steam from the ovens, to the air of work environments.

Sources:
- RATIONAL USE OF ENERGY: WINNING STRATEGIES FOR THE FOOD BUSINESS - Università degli Studi di Milano Dipartimento di Ingegneria Agraria
- http://www.leonardo-energy.org/energy-efficiency-food-beverage-industry

Code 10.81 PRODUCTION OF SUGAR

PRODUCTION OF SUGAR FROM SUGAR BEET: The refining is concentrated in 2-3 months per year that coincide with the period of harvesting of beets. The processing methods are now aligned with the latest process technologies. For the sugar processing is used steam with non significant temperatures.

Sources:
- http://www.leonardo-energy.org/energy-efficiency-food-beverage-industry

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BEVERAGE INDUSTRY [ATECO 11]

BREWING: Brewing, ignoring all the intermediate steps of the product, presents two phases with high enough temperatures: drying (drying + roasting) of malt that for dark beers reaches 200 °C and the wort cooking. The hot wort at about 95 °C is sent to the heat exchanger where it is cooled to the desired temperature depending on the type of beer to be produced: 10 °C and 20 °C, respectively for low and high fermentation beers, in which the fermentation temperature varies from 5 °C to 21 °C depending on the type of beer. The process is not continuous but is made by loading and unloading of the dryers and of the fermentation silos. The drying occurs in hot air ovens.

Sources:

– http://www.leonardo-energy.org/energy-efficiency-food-beverage-industry

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WOOD INDUSTRY AND MANUFACTURE OF FURNITURE [ATECO 16 e 31]

The wood is used in several areas, particularly in the construction industry for the construction of formwork, in the building industry for windows, doors and ceilings, in the paper industry for the production of cellulose, in the manufacture of containers for packaging, from agricultural to machinery, finely the more important use of wood is surely the production of furniture, chairs, tables and other components.

The life cycle is very fast in some cases for example in disposable formwork for concrete, sometimes much more complex as the furniture. We thus have on one hand the production of waste and residues within the processors, with production concentrated enough, the other end of life products to be launched to select collections of waste products as well as that flows into the mainstream of unsorted municipal.

The recovery and reuse of wood has long since practice began and spread, and is on a separate consortium required between industries, the Rilegno, which collects these materials. The flow of such recoveries, complemented by strong imports, the order of 1-2 million tonnes a year, ends up primarily for the industries that produce low or medium density panels, panels that reenergized the production of packaging and furniture. Please note that according to EU directives, management of waste recovered as raw material is a priority as compared to energy recovery.

The situation of companies that have scraps from wood working is heavily different from the precedent. On one hand these companies may be interested by the processing of these residues into thermal energy or into mechanical energy or to produce steam for power presses and for accelerate bonding; on the other hand these companies want to consume all the residues by themselves for not having to manage disposal exterior, inasmuch these products, also for the presence of glues and paints, are classified as hazardous waste originate from production activity, although not dangerous. This explains why the investigation carried out by CTI in Brianza, to investigate the possibility of biomass district heating networks, by reading the MUD records of discharge of waste, availability of material not relevant to power plants outside.

Surveys conducted in Brianza (Chart 1) as well as those made by the University of Trieste in Friuli, confirm the presence of boilers in companies, usually fairly high power, managed without particular attention to aspects of energy efficiency, as indicated by the very high temperature the chimney, because these are secondary to the needs of production and consumption of wood waste. For all these reasons, the data on the actual availability of scraps are often reserved, not monitored, undocumented and not well known.

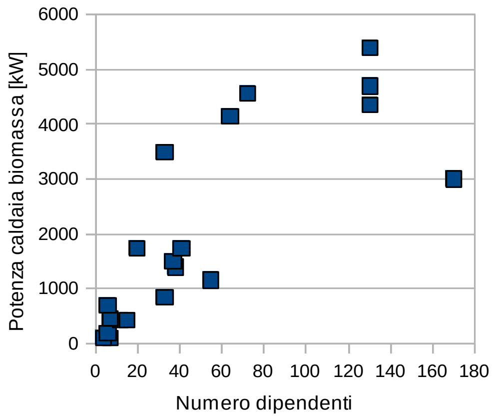

Chart 1: Nominal power of biomass boilers and number of employees of the company. Data from Biomass Use in Brianza - CTI 2004

The pressure of the steam produced for presses isn't very high, so probably there should not be difficulty to produce this steam with a cogeneration ORC system.

The priorities of these facilities are however the production needs, such as work organization, number of shifts and scheduling application of heat and steam.

Sources:

- Biomass Use in Brianza" Thermal utilization of virgin and residual Biomass in Brianza (Italy) for district heating and electric cogeneration – CTI 2004
- Analisi delle prestazioni dei gruppi cogenerativi orc per lo sfruttamento degli scarti dell'industria del legno - G.Bonetti˙, P.Pinamonti*, M.Reini

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MANUFACTURE OF COKE OVEN PRODUCTS [ATECO 19.1]

With coke oven products are mean:

- Tar distilled from coal, lignite or peat, and other mineral tars;
- Coke of lignite (brown coal distillation at low temperature);
- Coke for non-energy use (artificial graphite, retort coal and coke for electrodes);
- Coke oven coke (obtained from the high temperature coking coal);
- Gas coke (a by-product of gas works);
- Industrial services for coke oven products.

From the point of view of heat recovery analysis **focuses on the production of coke oven coke** since this type of production has the highest presence of waste heat.

The coke oven coke is a carbonaceous solid residue of bituminous coal with low sulphur and ash, from which the volatile components were extracted trough baking at a temperature of about 1000 °C and without oxygen. This procedure allows to cast the fixed carbon with the ash getting just the coke.

Coke is used as a fuel and reducing agent in smelting fornace metallic ores (coke produced as a residue of petroleum refining process may resemble the one coming from coal, but contains too many impurities to be used in metallurgical applications).

In addition to the recovery of heat from the ovens to produce coke must also consider the possibility of exploiting the coke oven gas which are waste gases by dry distillation and can be used as fuel for power plants (there is one of 24 MW one at the ItalianaCoke).

Sources:

– www.italianacoke.it
– www.eni.com

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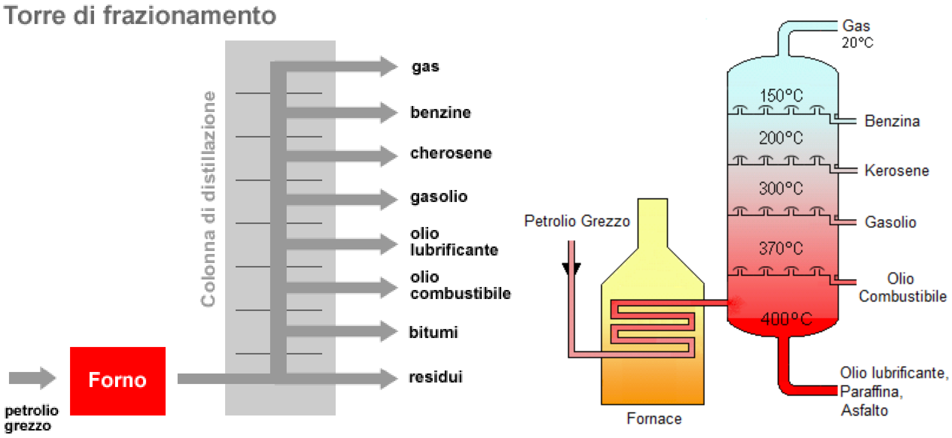
MANUFACTURE OF PETROLEUM PRODUCTS DERIVING FROM REFINING CRUDE OIL [ATECO 19.2]

The petroleum refining is a process of transformation of crude oil in a number of derivatives.
After deleting some salts are often present (desalting), starts the distillation phase of crude oil which produces different fractions (cuts) of hydrocarbons according to their boiling point.



In terms of heat recovery, since the gas leaving the cooling tower have temperatures in the range of 20 °C, the study should focus on **the exhaust gases of the furnace because it works continuously and at temperature high enough because must carry the crude to a temperature of 400 °C before entering the cooling tower.** It is important should try to understand what is the outlet temperature of the gases from the furnace and if they are already employed or not in the crude preheat.

Sources:
- www.eni.com
- www.ecoage.com

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MANUFACTURE OF CHEMICAL PRODUCTS [ATECO 20]

ATECO 20.11 MANUFACTURE OF INDUSTRIAL GASES

PRODUCTION OF TECHNICAL AND MEDICAL GASES: The sector includes the production of many gaseous substances (the main ones are oxygen, nitrogen, argon, carbon dioxide, hydrogen, acetylene and specially gases), used by a wide range of industries as intermediate products for processing operations. The process of separating air from the components of interest (industrial gases) requires huge amounts of energy for continuously moving the air through the various systems and for decomposing it into its constituent parts. Moreover, the distillation is also to be considered: pure oxygen is obtained by boiling the mixture to eliminate nitrogen. Air is the raw material from which are extracted gases such as oxygen, nitrogen, argon and other rare gases in their purest form.

The industrial gases are obtained by means of the column of air separation. The compressed air is liquefied and separated by means of heat exchangers. Liquefaction takes place at extremely low temperatures that reach -196 °C. Since the different components of air gasify at different temperatures, they can be separated through a distillation process.

Sources:

- http://www.messeritalia.it

ATECO 20.12 MANUFACTURE OF DYES AND PIGMENTS

PRODUCTION OF PIGMENTS FOR PAINTS: inorganic solids, with the presence of one or more transition metals in combination with other elements. The ceramic pigments are usually obtained by high temperature firing of mixtures. The process also requires that the product obtained is purified from the contained dross with the passage through cleaning tanks, after which the pigment is dried in drying chambers, pulverized and packaged.

Sources:

- Manuale di trattamenti e finiture cap. 6 Tecniche Nuove

ATECO 20.13 MANUFACTURE OF OTHERS INORGANIC CHEMICAL PRODUCTS

PRODUCTION OF ULTRAPURE SILICON FOR WAFER: Silicon is commercially prepared by heating silica with a high degree of purity in an electric furnace with carbon electrodes. At temperatures above 1900 °C, the carbon reduces the silica to silicon. The silicon fluid is collected in the bottom of the furnace and then cooled. This silicon is the Metallurgical Grade Silicon (MGS) and is 98% pure. To achieve higher levels of purity for the production of semiconductor electronic devices, further purification is required, for example with the Siemens method. In the Siemens process, ultrapure silicon rods are exposed to trichlorosilane at 1150 °C.

Sources:

- http://www.covalent.co.jp/eng/products/wafer/process.html
- http://www.carbonandgraphite.org/pdf/silicon_production.pdf
- Nagamuri, N., I. Malinsky, & A. Claveau, "Thermodynamics of the Si-C-O System for the Production of Silicon Carbide and Metallic Silicon" Metallurgical Transactions, 17B, 503-514, (Sept. 1986)
- MEMC Electronic materials Bolzano

ATECO 20.14 MANUFACTURE OF OTHERS ORGANIC CHEMICAL PRODUCTS

PRODUCTION OF POLYETHYLENE:

The polymerization reaction requires special reaction conditions.

For industrial production, the possibilities are:

- High pressure process = high temperature (about 80-300 °C), high pressures (about 1000-3000 bar) and presence of radical initiators (peroxides or oxygen).
- Low pressure process = with the use of catalysts based on transition metals. Polymerization with metallocene catalysts (first-and second-generation) with process in gaseous phase and solution.

PRODUCTION OF POLYPROPYLENE: propylene derives from the cracking in refinery and must be purified from residual water, oxygen, carbon monoxide and sulphur compounds that can poison the catalyst. The process occurs at 60-70 °C and at 10 atm pressure. The reaction is exothermic and the reaction environment is cooled by means of coils and the monomer feeding (ΔH = 25 000 kJ \ kg).

PRODUCTION OF NYLON: The product of polymerization by condensation of hexamethylenediamine and adipic acid leads to the most popular nylon. In the process of adipic acid production the operating temperatures are about 200 °C, whereas for the alternative of surface polymerization the temperatures drop down to around 0-50 °C.

Sources:
– POLIPROPILENE etc. = Whiteley, Kenneth S., T. Geoffrey Heggs, Hartmut Koch, Ralph L. Mawer, Wolfgang Immel (2000). Polyolefins. Ullmann's Encyclopedia of Industrial Chemistry

ATECO 20.15 MANUFACTURE OF FERTILIZERS AND NITROGENOUS COMPOUNDS

PRODUCTION OF NITROGENOUS FERTILIZERS: The input energy is composed of 50% of low temperature heat for the fermentation / distillation of the product, almost 20% of electricity and the rest from the combustion of petroleum and gas with these last ones that result virtually indispensable in the production of nitrogenous fertilizer.

Sources:
– http://www.apat.gov.it/site/it-IT/Temi/Suolo_e_Territorio/Agricoltura/Fertilizzanti/

ATECO 20.17 PRODUCTION OF SYNTHETIC RUBBER IN PRIMARY FORM

PRODUCTION OF SYNTHETIC RUBBER: the processing cycle that leads from polymer to finished product includes:

1- Working or chewing process to obtain soft and plastic elastomer. The process is executed into mixing closed sprockets (Banbury), in machines with cylinders or extruders (Gordon). The temperature tends to rise and must be maintained around 100-120 °C by cooling;
2- Forming is obtained by extrusion or calendering with a processing temperature maintained at about 100 °C; through pressing operations simultaneously to vulcanization. The vulcanization implies to reach a temperature of 140-180 °C and maintain it for a period that may vary from 1 to 30 minutes, depending on the mix and size of the article.

Sources:
– Manuale di tecnologia della gomma. Gesto Edizioni.

ATECO 20.3 MANUFACTURE OF PAINTS, LACQUERS AND ENAMELS. MANUFACTURE OF PRINTING INKS AND MASTICS

PRODUCTION OF PAINTS: Raw materials for obtain paints can be divided into at least five main classes:

- Resins incorporate all the raw materials classes as well as giving the chemical and physical characteristics to the film obtained.
- Solvents have the task of regulating the viscosity and the distension of the painting product on the support.

- Pigments are needed to provide a specific colour and increase the corrosion resistance of the covered surface.
- Charges such as carbonates, silicates or sulphates improve rheological functions, resistance to corrosion and abrasion, adjustment of the solvents evaporating time and contrast in the flotation of pigments.
- Additives have the tasks of preventing and/or correct defects of coatings and of definitely improving the quality.

Alkyd resins are reaction products of polyesterification that occurs between an acid or an anhydride and an alcohol. In order to improve the performance of workability of the resin and those of the applied film, a third element consisting of a fatty acid or a triglyceride (oil) is added.

Fatty acids or parts of oil can have animal or vegetable origin and may have carbon atoms with many, few or no double bond. Technically, final products that contain double bonds on oil are defined as unsaturated, mono-unsaturated in case of a single double bond and saturated in case of no double bond. The content of double bonds in alkyd resins has an importance related to their degree of air drying, according to which are divided into: drying, semi drying, non drying as they are, respectively, unsaturated, monounsaturated or saturated. Drying and semi drying are typically used for the production of enamels or mono-component paints, non drying resins are used for the production of baked enamels or two-component products. The short and medium oil alkyd resins are suitable for the production of quick-drying enamels used by spray guns, by airless spray guns or by electrostatic applications.

PRODUCTION SYSTEM OF ALKYD RESINS

The polymer formation requires at least two essential requirements:

1) Both the acid and alcohol must have at least two functional groups;
2) The polyester formation is accompanied by the production of water up to a point of no more product formation and with a balance between components and products of the reaction according to a physical law of mass action due to a constant: K = (polyamidoacid) (polyalcohol) / (polyester) (water).

In order to lead the reaction toward the product is necessary to proceed according to three key ways: increasing the temperature, increasing the components of the reaction, lowering the reaction products. This last way is the more feasible one and provides for the elimination of the water produced by using a solvent azeotrope.

From fatty acids, polyols and polyamidoacid: once all the components have been placed in a special reactor and mixed with a mixer, then the necessary solvent azeotrope is added in order to separate the water formed during the esterification process. This physical mixture is heated till a temperature of about 200 °C for the time necessary to complete the reaction. From oil, polyalcohol and polyamidoacid: oil consists of a triglyceride that is the ester of fatty acid with glycerine.
To obtain the monoglyceride or the fatty acid it is necessary to make a trans-esterification by adding a basic catalyst at temperatures around 250 °C. By means of appropriate test procedures, is found the end of transesterification, the temperature is decreased of 50-60 °C and polyamidoacid and the azeotrope agent is added. Tests to verify the "end" of the reaction in both production systems are implemented in order to obtain coincidences with the values of viscosity and acid number as reported in the specification of the target resin. If the pre-test confirm the fitness in terms of chemical and physical characteristics, the resin is then conveyed in special dilution solvents tanks, filtered and ready to be packaged for the final market.

Sources:
- Manuale di trattamenti e finiture cap. 6 Tecniche Nuove

Code 20.6 MANUFACTURE OF SYNTHETIC AND ARTIFICIAL FIBRES

PRODUCTION OF ARTIFICIAL FIBRES:

The most commonly used artificial fibres are obtained by treating natural cellulose of different plants (which is the same of vegetable fibres), suitably transformed and dissolved by means of solvents and then spun as a fibre wire. The fibres can also be used in artificial staple fibres (discontinuous fibre) obtained by cutting processes. Other artificial (not with widespread use) have protein source (e.g.: Merinov, Lanital). · Viscosia · Modal · Cupro · Acetate · Lyocell.

PRODUCTION OF SYNTHETIC FIBRES: Synthetic fibres are derived from organic synthetic substances (for the most part from the distillation of petroleum) that are polymerized to obtain long molecular chains (macromolecules) with form of continuous filament or staple fibres (discontinuous fibres). Acrylic · Modacrylic · Nylon · Polyester · Polyurethane. The process temperature is 170-180 °C average. The polymerization reaction requires special reaction conditions. For industrial production, the possibilities are:

- High pressure process = high temperature (about 80-300 °C), high pressures (about 1000-3000 bar) and presence of radical initiators (peroxides or oxygen).

- Low pressure process = the use of catalysts based on transition metals. Polymerization with metallocene catalysts (first and second generation) with gas phase process and solution.

Sources:

- http://assofibre.federchimica.it/assofibre

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MANUFACTURE OF GLASS AND GLASS PRODUCTS [ATECO 23.1]

Installations for the manufacture of glass are divided into two main types:

- Plants for producing flat glass
- Plants for producing hollow glass

The exhaust gases from the furnace of the two production processes have different features especially related to raw material and the type of fuel used during the casting process.

Flat glass requires a level of purity higher than hollow glass: raw materials and fuels used in the production process of flat glass lead to an exhaust gas from the oven cleaner than gas exhausted during the manufacturing process of hollow glass. This translates into lower investment costs for the part on the heat exchanger to recover primary.

The high temperatures of exhaust gas (only a fraction of the heat energy contained in them can be used internally in the process) and limitations on the minimum cooling temperature (about 200-220 ° C) allow heat recovery at temperatures allowing the production of electricity with high efficiencies. The energy request to manufacture a ton of flat and hollow glass is about 3,5 ÷ 6,5 GJ/t (1 ÷ 1,8 MWh/t) (estimation in BAT in the glass manufacturing industries), till ~40 GJ/t for others type of products.

On average, about 30% of the total energy supply during production is dispersed in the exhaust gases. Assuming that only half of the thermal power available is actually recoverable, and assuming conversion efficiencies of 20% is obtained, therefore, that the amount of electricity produced is in the order of 30 ÷ 55 kWh per ton of glass. The national production of glass is estimated at ~ 1 Mt / year of flat and ~ 3.5 Mt / year of hollow glass, excluding others glass products (yarn, wool, glass, pipes, etc…), it follows that the potential electricity production trough heat recovery in the field of glass production is 160 GWh / year. This value is very similar to that obtained with the proposed method of calculation, based on a comparison of CO_2 allowances allocated to companies for the years 2008-2012. It is clear that recovering energy from this industry could lead to results not negligible at the national level.

Sources:

– cfr. “*Reference Document on Best available Techniques in the Glass Manufacturing Industries*”, European IPPC Bureau, Draft 2 July 2009, pag. 4, 9, 13, 88. Le BREF sono consultabili online dal sito http://eippcb.jrc.ec.europa.eu/reference/

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MANUFACTURE OF REFRACTORY PRODUCTS [ATECO 23.2]

ROCK WOOL PRODUCTION: the process of production of rock wool begins with the fusion of volcanic rock at a temperature of 1500 °C.

GLASS WOOL PRODUCTION: is produced by bringing the mixture of sand and glass at a fusion temperature between 1300 and 1500 °C. This mixture is then converted into fibres by adding a binder. The fibre is then heated to about 200 °C and then calendered to increase strength and stability. The fibreglass is cut into rolls or panels using high pressures as final process.

Sources:

- www.aimnet.it

PRODUCTION OF BRICKS: The volatile organic compounds (VOCs), caused by cooking the honeycombed brick, are created by the thermal post-combustion of the furnace fumes with heat recovery for the after-burner, dryer and extruder. The heat recovery of energy from waste allows to almost completely overcome the energy cost of purification with post-combustion, reducing it to 4% of energy expenditure in post-combustion without recovery. In other words, the post-combustion in this system is almost free of charge. The honeycombed bricks have a uniform structure characterized by a myriad of small microvoid, not larger than 2.5 mm and not inter-communicating, that lead to weight loss and especially to a decrease of the material thermal conductivity, without losses on its mechanical strength. The honeycomb structure is obtained by adding the dough balls of expanded polystyrene (sometimes in combination with other additives such as sawdust, paper sludge, coke, olive pits, rice husks) that are burned while cooking and leave a blank space, i.e the alveolus. Reactions of pyrolysis and of incomplete combustion of these additives lead to the formation of organic substances, including aldehydes, as well as other substances of different nature (VOCs) that are emitted from the chimney of the oven.

Sources:

- Recupero calore del disperso e riduzione del carico inquinante nel processo di produzione dei laterizi G. Nassetti, C. Palmonari Centro Ceramico - Bologna Via Martelli 26 - 40138 Bologna
- Le più recenti innovazioni nei processi di cottura dei laterizi-L'industriadei Laterizi • gennaio febbraio 2007

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MANUFACTURE OF CEMENT, LIME AND PLASTER [ATECO 23.5]

ATECO 23.51 MANUFACTURE OF CEMENT

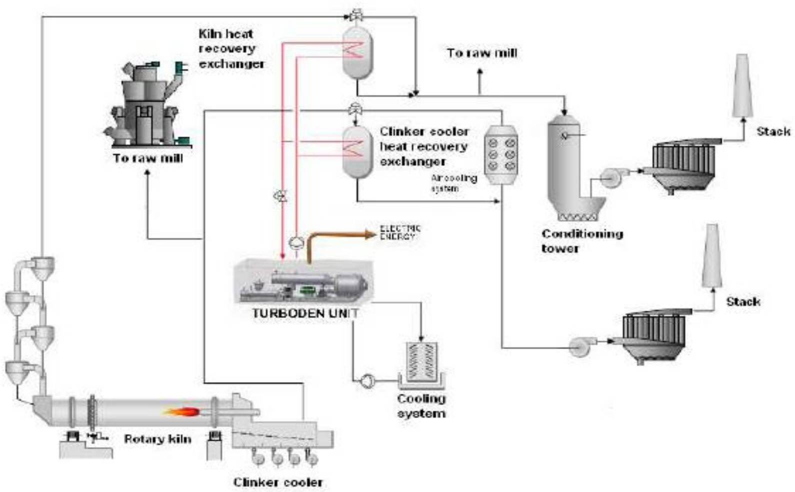
In the process of cement production there are two different heat sources suitable for applying an ORC system:

- Exhaust gases from the furnace clinker production;
- Air for cooling the clinker leaving the kiln (clinker cooler).

Usually gases leaving from the oven (about 1,200 °C) are used to dry and preheat the raw materials while these through the cyclone, while air cooling the clinker is partially used as combustion air in the oven and partially sent to the grinding mill of raw materials.

The temperature at which there are two sources of gas after the internal use at process(available for heat recovery) is relatively low (about 250 ÷ 350 °C).

The costs to invest in heat recovery in the cement industry are particularly high for the volume, but specially for the properties of gases that must be treated: in facts the air cooling the clinker, and gases from the kiln are characterized by a large dust content (typically 10 g/Nm3 ÷ 50). In addition, another critical point that characterizes the exhaust gases from furnace, besides the amount of dust, is caused by the type of fuel used, including heavy fuel oil, municipal solid waste, tires, etc...



On average, the production of cement requires from 90 till 150 kWh of electricity for ton of clinker produced, and about 3650 MJ/t of thermal energy (~1MWh$_{t)}$.

In industry of cement production there are successful heat recovery applications both with steam turbine that with ORC technology, and, considered that Italy produce 47 Mt/year of cement, the national energy saving could be relevant.

Sources:

- [cfr. "*Reference Document on Best available Techniques in the Cement and Lime Manufacturing Industries*", European IPPC Bureau, Draft 2, May 2009 - pag. 47].

ATECO 23.52 MANUFACTURE OF LIME AND PLASTER

The process of lime production does not differ much from that of cement (the ore must be "cooked" at high temperature), although the cooking times are higher.

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STEEL INDUSTRY [ATECO 24.1]

HEAT TREATMENT OF METALS: The heat treatment process on steels is used to increase the mechanical and chemical characteristics of the raw material (e.g.: high superior hardness and/or corrosion resistance). The treatment is carried out in ovens (Muffles) where the internal chamber temperature is automatically regulated up to a maximum of 700-800 °C during a time period depending on the characteristics required by the target product. The pieces are loaded through the opening/closing of a loading/unloading hatch. The warm-up heat can be generated from the combustion of natural gas in case of large objects, while in the other cases by means of induction heating of electric heaters (hardening of small pieces). In the first case, the audits with furnaces manufacturers have underlined how the related waste heat are interesting in terms of temperature and fumes quality (low fouling factor), but the thermal capacity and the number of hours of continuous operation in a medium size oven are relatively low because the process is not continuous but in BULK.

Considering that the smoke at the chimney has an outlet temperature of 600 °C with flow rates of about 250Nm3/h for an average operating 2000 hours/year, it is necessary to collect the oven fumes in a single aspiration duct and have a number large furnaces (15-20) to ensure the economic return on the investment. The plants size in the heat treatment environment is mainly small and even if the size is not a limit, then it is very difficult if not impossible to collect all the fumes because of chemical/physical compatibility among the various types of discharges (the heat treatments can be thermo-chemical) or because of lay-outs that do not involve this kind of additional plants.

Sources:
- IMPROVING PROCESS HEATING SYSTEM PERFORMANCE FOR INDUSTRY U.S. department of Energy
- Improving thermal efficiency in process eating equipment Meastri Fonri

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MANUFACTURE OF STEEL PIPE, TUBES, HOLLOW PROFILES AND RELATED ACCESSORIES (EXCEPT THOSE IN CAST STEEL) [ATECO 24.2]

The analysis and assessments provided in this paragraph are relative to a single process in the steel industries, that is the application of systems for heat recovery with electrical power production **from reheating oven** (ex: Kilns plants rolled, forged, heat treatment). The greater potential is inherent in the melting process itself, but to date has not indifferent to technological problems. Instead, the process of reheating furnaces does not present particular technical difficulties, except possible constraints due to the positioning of new plant and equipment within an existing production facility.

These types of process, in fact, marry particularly well with the heat recovery technology by ORC for a number of reasons, including:

- The combustion of methane gas in reheating furnaces produces fumes virtually free of dust, which need no special treatment and filtration;
- The temperature range of exhaust gas (typically between 350 and 650 °C) enables the use of thermal oil as a carrier for the organic heat transfer fluids used in ORC cycles;
- The recoverable exhaust heat output of reheating furnaces is ideal for ORC cycles which, for electrical power between 0.5 and 5 MWel have yields equal to or greater than traditional cycles with steam turbine, presenting, in addition, some benefits in terms of conducting the installation;
- The rolling mills, in particular, operate typically on continuous cycles over 24 hours, and do not require frequent stops for maintenance.

For this reason, especially in the case of furnaces for heating slabs and billets in rolling mills, it is common to find systems for heat recovery, for:

- Pre-heating the combustion air with heat exchanger placed in exhaust gas or by using burners reclamation / regeneration;
- Generation of hot water used for heating of offices / city districts / industrial uses inside or outside the establishment.

For a typical heating furnace, the flow of energy corresponding to the exhaust gas is slightly less than 30% of the heat from the combustion of natural gas, which can be estimated, on average, about

1.55 GJ / t (430 kWh / t). It is clear that an additional system recovery for pre-heat combustion air, mentioned above, is at least advisable.

Where a heat recovery is not possible, or was unhelpful, the alternative electric power generation is of definite interest.

In these plants, the typical configuration of the system for heat recovery consists of a recovery system for the interception of the exhaust gases of the reheating oven which transfers heat to the thermal oil, which is used as energy source and transfers the heat to the ORC module, which produces electric power.

The heat discharged from the turbogenerator for condensing working fluid is passed to a circuit of cooling water (at 25 / 50 °C), and may, as appropriate, be discharged into the atmosphere (through towers and evaporative air-coolers) or used for thermal loads internal to the production process.

Sources:

- [cfr. "*Reference Document on Best available Techniques for the Production of Iron and Steel*", European IPPC Boureau, Draft 2, July 2009].
- [cfr. "*Reference Document on Best available Techniques in the Ferrous Metal Processing*", European IPPC Boureau, December 2001 – pag. 64].

STEEL PRODUCTION WITH ELECTRIC FURNACE: The fumes from the steel production are aspirated from the 4th hole and sent to a conditioning tower through two chambers of sedimentation by means of pipes whose walls are made of water-cooled tubes (tube to tube). Downstream of the tower fumes pass through two cyclones before being released into the atmosphere and are merged with the fumes from the secondary and then filtered. The high capacity of gas sucked from the 4th hole leads to very high speeds implying high abrasiveness together with the presence of dust. To be evaluated the possibility of heat recovery after the sedimentation chamber and after the quenching tower where the fumes are cleaner, but the energy that can be recovered is less.

Sources:

- OFFICE OF INDUSTRIAL TECHNOLOGIES ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

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MANUFACTURE OF ALUMINIUM [ATECO 24.42]

PRIMARY ALUMINUM PRODUCTION: The methods for industrial production of aluminium, include obtaining pure alumina from bauxite which is easily extracted but the process for isolating the aluminium content is quite complex and is completed in two phases: the first is a chemical phase and allows the production of alumina (Al2O3) in which the energy consumption of the process is evaluated in the equivalent of 0.4, 0.5 tonnes of coal per tonne of Al2O3 produced, the other one is an electrolytic phase in which alumina is reduced to metal. The production of 1 kg of aluminium the electrolytic process requires between 17 and 20 kW of power (more than the need of the Bayer process for the processing of bauxite into alumina). This leads to the strong dependence of the total costs from the energy cost, as the cost of raw material is relatively low. The production of 1 kg of 99.6% aluminium requires about 20-25 kWh and 4 kg of bauxite.

SECONDARY ALUMINUM PRODUCTION: Refiners (those engaged in the production of casting alloys starting precisely from scrap aluminium) and "remelters" (i.e.: those engaged in the production of plaque rolling or extrusion billet) of aluminium choose different approaches. The types of scrap they buy are sampled, with their chemical composition determined in a test recasting. The data reported in this way are stored in a computer for each purchased lot. If a customer, for example, requires a certain type of alloy, based on the material sampled and stored, the computer puts together a charge that is close to the chemical composition of the alloy to be produced. After the scrap casting, the liquid metal is loaded into a converter to produce the required alloy through a purification process and, if necessary, through the addition of alloying elements. If an alloy is produced from scraps, the scrap already contains most of the alloying elements. The advantage of this process is obvious: its costs are reasonable and, most importantly, puts the refiners and the melters capable of producing high quality alloys that meet customer demands. Aluminium scrap is today an essential raw material for the light metal industry, as it can be transformed into casting alloys and wrought of high quality. As a consequence, the aluminium scrap is a valuable material, and the law should treat it to avoid it goes dispersed, and to make him fall continuously in the production cycle.

To reach the melting point of scrap in the furnace it is necessary only 5% of the energy used for the electrolysis (Primary aluminium). Disk fragments of cans are melted by using a crucible furnace model Number 40HW Starrbide with a maximum capacity of 48.6 pounds (approximately 22 kg) of molten aluminium. Before the merging and the de-lacquering phases the crucible containing a certain amount of melting salts has to be put in the oven. During the de-lacquering process the related exhausted gases are used to preheat the oven at a temperature of about 500 °F (about 260 °C). Thereafter the burner of the furnace begins to work for bringing the temperature to 1120 °F (about 604 °C) and the salts melt. The disks are then inserted in the preheated melting salts bath. The number of disks placed in the crucible must respect the 8 to 1 weight ratio between disks and salts, as this ratio is the one that has experimentally provided the best yield of aluminium.

After this addition, the temperature continues to rise until it reaches 1220 °F (about 660 °C), then it is maintained constant as much as possible by using a digital thermocouple. The furnace is shaped like a cement mixer and is recovered by refractory bricks that are fixed to the shirt of the furnace through a refractory mortar resistant to fire and to high temperatures. On the furnace sole is then realized a seat of refractory bricks on which is placed the crucible. On the lower part of one side is placed an opening for the burner. This solution allows the flame to touch tangentially the crucible without investing it directly while "spirals" upwards in order to avoid the so-called “hot spots” on the crucible that are useful for all the crucible lower part. The refractory bricks hold the heat in the oven as well as it is possible to use for the melting process the same burner of the de-lacquering process, which is a small power burner (Hauck model AIG 230A (propane) with a capacity of 5 MBtu / h , corresponding to approximately 1.5 MW).

Since the furnace is integral with the heat recovery system, it is provided with the necessary openings for the pipes for conveying fumes. In particular, the inlet pipeline carries the fumes of the de-lacquering process that are used to heat the crucible with the melting charge before the melting process that is realized with the heat produced by the burner. The outlet pipeline evacuates the fumes of the furnace towards the filters chamber to remove the particulates.

A cover of galvanized steel and recovered by refractory bricks is placed for closing the furnace. As it is isolated by FiberFraxÒ, air infiltration is reduced so as the contact with oxygen (which could produce excessive oxidation of molten metal loss) and the heat loss in order to increase the efficiency of fusion. The melting charge used in this system, consisting of a mixture of 50% in weight of sodium chloride (NaCl) and of 50% in weight of cryolite (KAlF4), serves three purposes:

1) protection against oxidation,
2) degassing;

3) demagnetization of the molten aluminium

Experimental results have precisely determined this ratio of NaCl and $KAlF_4$ that melts before any other.

Using a charge with a melting temperature lower than that of aluminium, the furnace needs to be heated above this temperature (more than 1220 °F, i.e.: about 660 °C). This reduces fuel consumption but minimizes also the solubility of the gas. Since the alloys used for aluminium cans are typically three (3004 for the body, 5182 for the cover and 5042 for the tab), the result of the fusion will be a commercially unusable combination of the three elements. Most foundries use scrap cans as addition to their castings in quantities that will not modify the composition of the alloy. Since the studied system melts only used cans, for obtaining a commercially valuable standard league is necessary to add precise quantities of mother alloy.

The mother alloy includes elements as Cu, Si and Sr depending on the wanted type of alloy. Furthermore, since the cans have a high content of Mg, which embrittles the casting, then the alligator and the de-magnetization through the melting charge become necessary operations in order to produce a functional and efficient fusion. Before the exhaust gases leave the system, they are filtered through a filters chamber for removing the soot particles. The filters are Torit ® and handle around 1000 c.f.m. The filters chamber is connected to the heat recovery system. The air flow is controlled by a relief valve. The smoke temperature in the filters chamber is carefully and constantly monitored to ensure that it exceeds 100 °F (about 38 °C) as the filters are made of cotton and therefore can not stand high temperatures.

The heat recovery system is used to increase energy efficiency of the unit. This circuit includes de-lacquering furnace, the preheat furnace and the furnace for melting the scrap. When the de-lacquering furnace is running the hot gases are sent to the preheating furnace and to the melting one through a compressor. The furnace in this context works as an after-burner that destroys volatile organic compounds produced during the de-lacquering phase. Part of the exhaust gases are directed to the filters chamber, while the remainder returned to the de-lacquering furnace also through the compressor. Among the furnaces is placed a bypass which performs two functions:

- Evacuate the exhaust gases from the furnace when the casting is ready or when the operator makes the introduction of UBC disks in the crucible. In both cases, the butterfly relief valve (“butterfly dampers"), located just before entering the furnace, is closed while the one on the by-pass inlet is opened.

- Balancing the flows. In this case the by-pass and their valves shall adjust the speed of fumes flow through the various components.

Note that the ducts and compressors have been designed using the indications of "Sheet Metal and Air Conditioning National Association" (S.M.A.C.N.A.). In terms of energy efficiency, the thermal efficiency of metallurgical furnaces is about 36% and the furnace designed for the recycling unit has a thermal efficiency, obtained on a test basis, of 4.05% which is comparable to large industrial furnaces. A study conducted to determine the composition of fumes coming from the melting process has used, in order, three special air samplers:

- The first was applied to the fireproof overalls of the furnace operator;
- The second was applied to the assistance of the furnace operator that was at least 10 feet (about 3 meters);
- The third was placed approximately at 50 feet (15 m) from the furnace to determine the area of emission.

The samplers were active throughout the process time. All filters were then disassembled and shipped for the analysis to the "MDS" laboratory.

Results are presented in the following tab. IV:

Tab. IV: Analysis of the emissions of the furnace.

Pollutant Element	Sample 1	Sample 2	Sample 3
Chromium	< 8,9 mg/m^3	<32,3 mg/m^3	< 7,2 mg/m^3
Beryllium	< 8,9 mg/m^3	< 32,3 mg/m^3	< 7,2 mg/m^3
Arsenic	< 1,78 mg/m^3	< 6,45 mg/m^3	< 1,44 mg/m^3
Cadmium	< 0,18 mg/m^3	< 0,65 mg/m^3	< 0,14 mg/m^3
Lead	51,6 mg/m^3	< 32,3 mg/m^3	285,5 mg/m^3
Aluminium	4384,7 mg/m^3	22141,9 mg/m^3	9949,5 mg/m^3

These values represent 8 h of exposure.

Sources:

– http://aziende.aluplanet.com/ITA/home.asp

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MANUFACTURE OF LEAD, ZINC AND TIN AND SEMI-FINISHED PRODUCTS [ATECO 24.43]

LEAD: During the production of lead there is a process of **melting of pestle obtained earlier at the temperature of 800-1000 °C in a rotary direct-fired kiln using a mixture of oxygen and methane**.

Another interesting aspect for the heat recovery in the commercial production of lead is the use of **reverberatory furnaces during the refining of lead**. These ovens take the lead at 800 °C to oxidise tin, arsenic and antimony that remain so suspended in the lead bath. This process can also be made trough **chemical oxidation at a temperature of 420 °C**.

Please note that a large part of the production of lead is held by companies involved in the recycling of batteries.

ZINC: In the zinc production there are two different situations in which there is potential for useful waste heat for heat recovery:

- The roasting: **The sulphide ores must be roasted to convert the zinc oxide before the melt**. The roasting is usually performed in suspension roaster (flash) in which the concentration of finely divided zinc sulphide is blown into a combustion chamber and burned, similar to pulverized coal, or is used certain types of bed fluid roaster.
- The fusion: All pyro-metallurgical and electro-thermal processes are based on the highly endothermic reaction whereby the coal reduces the zinc oxide at a temperature of 1100-1300 °C, above the boiling point of zinc (907 °C). This should be enough to prevent oxidation of carbon to carbon dioxide because a high percentage of carbon dioxide re-oxide the zinc vapours during condensation. One of the processes of reduction with carbon is the retorts process, whereby heat is generated outside of the retort furnace where the reaction takes place.

TIN: The majorities of tin is extracted from alluvial deposits of cassiterite by processes of grinding and finally of flotation for eliminate the sulphides of other metals. So it's possible obtain concentrated mixtures with high content (90-95%) of SnO_2, which, after roasting in air, can be used to reduction with coal.

A substantial amount of tin is also recovered from scrap alloys (bronze, welding residues) that are normally recovered or recycled in some stage of the production process of metal, particularly scrap metal from tin (tin foil). The scraps can be treated with chlorine at room temperature recovering tin volatile $SnCl_4$ or treated with alkaline solutions resulting in a solution containing tin that is subjected to electrolysis.

Sources:
- www.piomboleghe.it
- www.minieradiraibl.it
- www.cobat.it

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MANUFACTURE OF COPPER AND OTHERS NON-METALLIC PRODUCTS [ATECO 24.44 e 24.45]

ATECO 24.44 MANUFACTURE OF COPPER

PRODUCTION OF PRIMARY COPPER: In Europe don't exist mines to extract primary copper. The major mines are located in CHILE, CONGO, PERU, ZAMBIA, CANADA and RUSSIA.

PRODUCTION OF SECONDARY COPPER: Copper recycling means to save 85% of the energy needed to produce the primary metal (ref. Bureau of International Recycling). In Europe there are multinationals operating in the processing of raw materials into tubes, plates and fittings of various kinds (www.feinrohren.it, www.foma.it, www.kme- italy.com, www.luvata.com www.eredignutti.it, www.sanha.it). In all these cases the manufacturing process is continuous so they are potential candidates for achieving extensive audits. The most technologically advanced nations recycle products containing copper at the end of their life cycle: for example, copper is the most available raw material in Italy where don't exist mines.

This helps to reduce dependence on imports. Consumption of copper (including the content of the alloys) 1,167,200 tonnes (2002-2006) with import of Copper (refined): 684,100 tonnes. To extract copper from ore, the required energy is about 100 GJ/ton, while recycling copper requires about 10GJ/ton. The most commonly processes used in secondary copper recovery are pre - processing of scrap metal and fusion. The processes most commonly used in the recycling of scrap copper are:

- Blast Furnace: vertical shaft furnace with the capability of melting copper or copper-based materials of different chemical or physical composition. The unit commonly used in the treatment of secondary materials with low copper content and has a high control in the system loss of metal [Nelmes 1984];
- Reverb furnace: active since the nineteenth century. It's still used for the production of a significant fraction of primary and secondary copper and for recycling secondary scrap metal. The disadvantages of this furnace are the length of the cycle and low power efficiency [Davenport 1986];
- Electric arc furnace: is also used for casting of secondary copper. The electric arc furnace is classified at 72 tonnes and produces from 310 to 330 tonnes per day [Blanton 1999]. The load is 75% - 80% scrap and 20% -25% of bars.

Sources:
- http://www.kupfer-institut.de/lifecycle/
- http://www.codelco.com/english/desarrollo/fr_prioridad.html
- http://www.codelco.com/english/desarrollo/fr_prioridad.html
- http://www.copper.org/education/statue_of_liberty.hml

ATECO 24.45 MANUFACTURE OF OTHER NON-FERROUS METALS

PRODUCTION OF COPPER ALLOYS BRASS: The production of brass in Europe is concentrated in products by rolling or by wire drawing of different sizes. The companies producing copper alloys generally provide rods or plates large dimensions that are sold to extruders for getting profiles of different shapes and sizes. Copper alloys are produced by melting scrap metal (including chips). Usually the furnaces are with crucible and are equipped with channel and have a pre-load chamber. These ones can be either gas or induction furnaces with not continuous charging (approx. 1 charge per hour). Upstream of the furnace there are usually natural gas rotary chambers for drying of brass chips that run in continuous, while downstream of the melting furnace there may be one or more furnaces that heat the billets for further processing (extrusion in press) and also heat treatment furnaces. These kinds of furnaces are powered by natural gas. The larger potentiality for heat recovery has been found in furnaces for chips drying (drying drums with natural gas burners) because the gases has to pass through a post combustion chamber (with additional natural gas burners) where temperatures reach 850°C. The exhaust fumes coming from the post combustion chamber (about 37500 Nm3/h for each system treating about 15 t/h of chips) pass through cyclones and then through a heat exchanger fumes/air (three steps in multi-tubes for vertical fumes, height about 3 meters and diameter 2") in order to lower the temperature needed at the sleeve filters inlet till to temperatures preferably not exceeding 120 °C (or 200 °C for sleeves with more expensive material). The furnace operates in continuous. In addition, the preheating furnace may also be more than one, but not located in the same area of the company. Others waste heat are derived from: cooling water circuit of continuous casting. A large plant has a capacity for cooling water of 550 Nm^3/h at a pressure of 10.5 bar for a 6-wire continuous casting, with a temperature delta in cooling tower of about 10 °C and cannot normally be changed because of its strong influence on the production process. There are also circuits for cooling oil through a cooling tower where the temperature is about 40 °C.

Fumes from melting furnaces: the casting process consists currently of four furnaces (each equipped with its own duct) with an additional one as standby furnace. The aspiration system consists of fume ducts, a cyclone section, batteries of sleeve filter and a chimney of 50 m in height.

According to the quantity of air extracted from the fans, the capacities are always very high but, due to the discontinuity of the cycle, high temperatures are reached only during the load of the furnaces. At the moment, an application of heat recovery for producing electricity is then excluded. The production lines are composed of the preheating furnaces for feeding presses. Each press is fed by one or more reheating furnaces. The furnaces do not generally have a recovery for the pre-heating of combustion air, but the hot fumes (at a temperature of about 750 ° C) are used for pre-heating of billets before entering the proper reheating furnaces.

Sources:
- http://www.bir.org/non-ferrous-metals/

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CASTING OF OTHERS NON-IRON METALS [ATECO 24.54]

DIE CASTING ALUMINIUM ALLOY: The necessary equipment for the production of die cast parts are specific to the process and are die casting machines or, more simply presses. The term is the abbreviation for casting under pressure and it defines the process where the molten alloy is poured into a metal mold (die) and subjected to a pressure that causes the following effects:

1. fast filling the die cavity,
2. compensatory nutrition of the solidification withdrawal (perfect and complete),
3. ensuring a fine crystalline structure to the piece.

In order of importance compared to the volume of manufactured products, the current materials of die castings belongs to the metals family of non-ferrous alloys: aluminium and its alloys (AlSi, AlSiCu, AlMg), zinc and its alloys (zamak), copper and its alloys (brass, bronze), magnesium and its alloys (AZ), tin and its alloys. The physical parameters more involved in the die casting process (according to the die volume) are as follows:

- Temperature, the standard distribution is as follows:
  - die: 200-300°C,
  - molten alloy: 650-730°C,
  - piece extraction 250-350°C.

The casting of the alloy occurs in melting furnaces that can be in island for the small companies or there may be large furnaces with big dimensions from which is pulled out through the ladle the aluminium quantity that is then poured into the maintaining or stand-by furnaces. In both cases, the temperature depends on the alloy and can vary from 650 °C to 730 °C. The furnace load is not continuous and is supplied by inserting aluminium ingots at solid state (with this technology, scraps cannot be used if not already refined, see aluminium refining). The furnaces are generally heated by natural gas, while the maintaining or stand-by ones can be also electric and the fumes are discontinuous with average temperatures of 550 °C with low and discontinuous flow rates. The necessary energy for melting a pound of aluminium alloy is equal to 493 btu at the reference temperature of 76 °F.

POURING IN GRAVITY OF ALUMINIUM ALLOYS: In this process, the molten metal is poured by gravity into a die without the application of external pressure. Concerning the melting furnaces and the standby ones the considerations do not change.

In both processes, even in the presence of large oxygen furnaces the related waste heat referred to casted tonnes e.g.: 140 tons/day are due to fumes at 550-900 °C temperatures with intermittent flow under 2000 Nm3/h and therefore not potentially interesting for the ORC application.

Sources:
- http://www.diecasting.org/training/energy/

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SUPPLY OF ELECTRICITY, GAS, STEAM AND AIR CONDITIONING [ATECO 35 (e 06 regard natural gas extraction)] (natural gas compression)

The gas compressor stations are placed along natural gas pipelines, these gas turbines which drive an axial compressor to compensate for losses during the transport, the average power is around 40MWe, corresponding to about 100-120 MW_t at the maximum temperature of 500 °C. Snam Rete Gas has 11 stations (Figure 1) for a total of approximately 850MW. These stations are located in remote places, often not even connected to the grid and with little opportunity to use the heat.

Add to this the fact that each plant has several compressors that work cyclically, so the single compressor runs on average a low number of hours per year. These plants are therefore not relevant for heat recovery with ORC.

A similar situation occurs at the compressor stations in stocks, although many of them are in the Valle Padana and better connected to the electric national grid. The Stogit (Figure 2) has seven power plants with gas turbines (Table 1) and one electric.

Edison Stoccaggio instead uses only electric compressors, also for the plants under construction.

Figure 2: Compression plants of Snam Rete Gas

Figure 1:

Stocks plants of Stogit

Località	MW meccanici
Cortemaggiore	61,18
Fiume Treste	61,64
Minerbio	64,48
Ripalta	46,54
Sabbioncello	21,8
Sergnano	44,65
Settala	21,34

Table 1: Mechanical power installed in the Stogit's compression plants.

Finally it's important to consider the compression plants of ENI Exploration and Production for gas coming from platforms in the Adriatico Sea. These plants (6 for overall 70 MW) have always at least active one compressor with mechanical power from 5 to 15 MW. On some of these plants, with a more regular operation, is in positive evaluation possible application of ORC modules.

Sources:
- www.snamretegas.it
- www.stogit.it
- www.eni.com
- www.edisonstoccaggio.it

SOME EXEMPLES OF EXISTING PLANTS FOR COMPRESSION OF NATURAL GAS:

- The existing plant at the GE-O & G facility Florence is a power producing plant with combined cycle, assembled and installed for the purpose of study by the R & D in the late '80s, when the plant was still owned by ENI, through its subsidiary Nuovo Pignone, and consists of a single shaft gas turbine Nuovo Pignone model PGT5, a steam turbine model NG25/20 and an Ansaldo generator model GSCB800Y4. The construction of the heat exchangers was implemented at the Nuovo Pignone establishment of Vibo Valentia. The power supply is approximately 6.5 MW with an efficiency of 31.5%.
- 3.1.1 TU / GAS - PGT5. This Pignone Gas turbine (as the acronym says PGT: Pignone Gas Turbines) has a 5 MW nominal shaft power. The mass flow is about 25 kg/s and the discharge takes place at 543 °C. Detected yield: 26.2%. The machine is designed to operate at a speed of 11600 rpm, and therefore a reducer gearbox is necessary for coupling the turbine to the generator.

- 3.1.2 TU/VA – NG25/20. Backpressure steam turbine, maximum power 2.5 MW with a 6.944 kg/s steam flow (50 bar, 450°C), typically used for a shaft power of 1.5 MW (capacity 10.15 t / h). The discharge takes place at 1 bar (a) and 101°C to prevent erosion of the low-pressure blades, and thus to limit maintenance costs. The yield reported is 20.9%. The machine operates at a speed of 3000 rpm without necessity of special devices for coupling the generator.

EXAMPLE OF HEAT RECOVERY FROM EXISTING SYSTEM FOR COMPRESSION OF NATURAL GAS:

Heat Recovery Steam Generator: it generates steam by heating water with the heat of the exhaust gas turbine. The exhaust gases enter at 543°C and exit at 218°C, water undergoes an enthalpy jump of 2845 J/g (from 90°C and 70 bar to 450°C and 50 bar). The yield reported is 87.4%.

Sources:

- http://www.web.ing.unipi.it/didattica/gestionale/descrizione_lt
- Analisi del bilancio energetico di uno stabilimento industriale e sintesi di interventi migliorativi Università di Pisa Facoltà di Ingegneria Tesi di Laurea Specialistica in Ingegneria Gestionale.

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WATER SUPPLY; SEWERAGE, ACTIVITIES OF WASTE MANAGEMENT AND RESTORATION [ATECO 38]

In table 6 is reported a schedule derived by ISPRA 2008 report, of plants located in Piemonte, Lombardia and Veneto for the disposal of waste of wood, paper and similar those treat more than 7000 t/y of waste. This category, at Italian level, represents about the half of special waste not dangerous.

The plants are technologically different, prevalent rotary oven; these are particular plants where the distribution of waste to be digest and the control of combustion products have the priority than the energetic aspects, some of these plants present a batch working others work in continuous with possible problems of non-continuous waste heat.

The heat exchanger for the ORC could be inserted in the loop for cooling of fumes with high attention to the corrosion problems due to possible presence of chlorine in the fumes and also to the temperature constraints of the batteries for catalytic treatment of effluents.

Given the above considerations it's clear that for estimate the potentially of ORC system in this type of plants it is necessary an analysis case by case.

For example the first two plants of the schedule, marked with an asterisk, generate also electric energy with a respectively nominal power of 7,5 e 6 MWel; The second one has a less installed power, also if this treats a double amount of waste.

Regione	Prov	Comune	Rifiuti totali trattati [t]
Piemonte	CN	Verzuolo	77165*
Lombardia	MN	Sustinente	152918*
Lombardia	PV	Mortara	78177
Lombardia	MN	Viadana	77766
Lombardia	MN	Mantova	68394
Lombardia	MN	Borgoforte	62857
Lombardia	MN	Pomponesco	42553
Lombardia	PV	Cigognola	15777
Lombardia	BS	Montichiari	7396
Veneto	TV	Susegana	49059
Veneto	TV	Spresiano	10684
Veneto	TV	Riese Pio X	9568
Veneto	PD	Fontaniva	7454

Table 2: Plants for the disposal of waste of wood, paper and allied products in Piemonte, Lombardia and Veneto - Source ISPRA 2008

Sources:

- www.isprambiente.it

ATECO 38.2 TREATMENT AND DISPOSAL OF WASTE

INCINERATION PLANTS FOR HIGH CALORIFIC VALUE WASTE (INDUSTRIAL, HOSPITAL, ETC).

These plants are generally used for incineration with or without energy recovery (waste-to-energy) from a wide range of medium and high net calorific value waste, such as textile residues, wood processing waste, paper, cardboard, plastic and rubber materials, resins, tires, tobacco processing waste and other agricultural waste, in addition to hospital and cemetery waste.

The range of production includes batch or continuous furnaces, with static or rotating combustion chambers. Destruction capacity ranges from a few kilograms per cycle to over 1000 kg/hour.

In order to achieve these performance levels, the biggest models can generally be equipped with an electro hydraulic load device, which enables waste to be fed into the combustion chamber also while running thereby increasing the daily destruction capacity of the plant.

According to specific requirements and environmental standards, all the furnaces can be completed with fumes treatment systems for the abatement of pollutant emissions in order to achieve full compliance with the limits imposed by national and international environmental regulations.

Even if this is not expressly required by the above described rules, the plants can also be equipped with heat recovery systems for the production of steam or hot water or for heating diathermic oil.

The reliability and environmental performance of these plants are of the highest level thanks to the use of an afterburner sized according to standards and a system for constant detection and recording of free oxygen, temperature and other pollutants.

The classic layout of these plants usually includes a section for waste feed and loading, a primary combustion chamber, a mechanical system for the waste evacuation, an afterburner chamber, a heat recovery system and lastly, a system for fume treatment.

However, the implementation is done in full compliance with current regulations.

The rotating combustion chamber is served by an automatic loading system managed according to the temperature in the chamber itself and made with several possible alternative functions depending on specific needs.

The combustion chamber is constantly discharged through a hydraulic-controlled sliding device which periodically enables the passage of ashes to a container underneath which is then lifted and tipped into a final roll-off container. An emergency flue is installed at the top of the afterburner which is sized to ensure that fumes remain not less than 2 seconds at a minimum temperature of 850° C or 1100° C depending on waste characteristics, with a concentration of free oxygen not less than 6%. The emergency flue has a safety check valve able to open automatically in the event of emergency or when electricity is lost. An explosion-proof safety door is built into the body of the check valve.

The system is equipped with pilot burners for the primary chamber and for the afterburner chamber. These ensure temperature is maintained at operative levels and quickly reached during the preheating phase, starting from room temperature.

An integrated system of probes for constant measurements of temperature and oxygen levels in the chambers, control microprocessors and electro mechanic starters for combustion air modulating valves, enables total control over the incineration process thus maintaining the flow and temperature of fumes at desired levels and in compliance with specific regulations.

Energy recovery, which is required by law in most cases, makes it possible to use a high amount of heat. Where energy recovery is not desired or not required, fumes still need to be cooled and in this case an adequate dissipation system is needed.

To neutralize fumes, in particular for decreasing HCl and SO_2, $Na(HCO_3)$ is used, sodium bicarbonate with active carbons added, following the proven dry process "Neutrec", which, instead of traditional systems based on calcium hydrate $Ca(OH)_2$ or Na(OH) in wet systems, enables a collection performance of 99.9%, enough to bring emissions in line with the strictest limits imposed on a national and international level.

BLOOD DRYING AND ORGANIC BYPRODUCT DRYING

These plants enable the transformation of sometimes highly polluting products, and at times even hazardous from a hygienic-health standpoint – such as slaughter blood or egg embryos used to produce vaccines – in a low water content product and with high protein that, where allowed, is used in making animal feed and high quality fertilizer.

High performance drying plants are developed to solve, in a rational and cost-effective way, the problem of treating waste that is highly polluting and difficult and costly to dispose of.

They were designed for improve thermal efficiency and to treat liquid to be dried in clean hot in air-flow without coming into contact with the flame or process fumes.

Also in this case the operating principle is based on rotation of the drying chamber where the material is constantly inserted. The material is mixed and fed into the cylinder with an exclusive patented rotating cage system while a parallel flow of hot air dries the product.

The entire system is self-cleaning and the rotation of the cage is made through the rotation of the drying cylinder. The material is crushed in the last part of the drying chamber with a duly shaped area at the end of the cage.

The crushed product then enters in the secondary drying chamber where it is sent towards the discharge hatch by a secondary cage system. Also here the flow of hot air finishes off the drying process. The mix of drying air and steam gradually produced by the material along its way inside the dryer is first sent to a cyclone dust separator and then to the thermo purification chamber for complete oxidation of the organic substances.

After cooling to about 400 °C when passing through the heat exchanger, the exhaust fume mix is finally sent into a cavity outside the drying chamber thereby providing additional heat to the product to dry through the metal wall of the chamber. Once the mix also leaves the cavity at a temperature of about 200 ÷ 220 °C, it is sent to the flue and dissipates into the atmosphere using the propulsion of a fume suction device placed at the end of the entire process.

The benefits of these systems compared to the corresponding direct flame system are the following:

• Drying is carried out with clean pre-heated in air-flow without the material coming into contact with the flame or the fumes of the fuel used for the process.

• It is possible to limit and modulate as desired the temperature of the process air thus reducing the thermal shock on the products to be dried.

• High thermo purification with peak turbulence of exhaust fumes leaving the drying chamber in order to eliminate any bad smelling fumes.

• Self-recovery inside the heat system provided in support of thermo purification as an energy source for heating process air.

HEAT RECOVERY PLANTS

These devices use the heat contained in combustion gas to exploit energy from waste.

Depending on the specific needs, the heat available from an incineration plant can be used to produce hot water, overheated water, high or low pressure steam or for heating diathermic oil. This can either integrate or replace the services of a traditional boiler operating with conventional fuels. The cost of these ones is constantly increasing, the recovery of heat from incineration fumes as well as being a necessary condition to satisfy the requirements of current legislation, is actually become a factor in the reduction of management costs. It is not rare the case of the initial investment cost amortized in a short time period. The different production models are supplied with the devices and technologies suited to their full capabilities.

Sources:
– http://www.ciroldi.it/it/spa/forni_rcm.html

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APPLICATION OF BIOGAS ENGINES – SLUDGES DIGESTION [ATECO 38]

These anaerobic digesters in which ferment mixtures of farm effluents, biomass from crops and potentially waste from the agri-food industry and water cycle, their number is growing more than 250, considering also the plants that don't take more incentive.

Under the rules of the current incentives are realized plants that produce biogas to food Otto engines with power <1 MW for all-inclusive tariff (tariffa omnicompressiva), parameter that fits our agriculture with a predominance of small farms; the heat gas discharge has corresponding thermal power too low for the purposes of the project.

Are still in use today, and encouraged by the GSE, power plants over 1 MW for about 50MWe in total, but only 3 exceed 3MWe (Table 3). Among the plants qualified to project for about 36MWe only one has a power higher than 3MWe.

Regione	Provincia	MWe
Lombardia	Bergamo	7,92
Piemonte	Torino	5,64
Piemonte	Torino	3,05
Piemonte	Padova	2,48
Lombardia	Brescia	2,31
Emilia Romagr	Ravenna	2,13
Emilia Romagr	Bologna	2,04
Lazio	Frosinone	1,67
Emilia Romagr	Bologna	1,42
Lombardia	Pavia	1,4
Emilia Romagr	Modena	1,3
Piemonte	Alessandria	1,19
Lombardia	Cremona	1,18
Lombardia	Milano	1,14
Veneto	Vicenza	1,12
Marche	Macerata	1,07
Emilia Romagr	Parma	1,06
Lombardia	Brescia	1,06
Piemonte	Alessandria	1,06
Piemonte	Torino	1,06
Veneto	Padova	1,06
Veneto	Venezia	1,06
Lombardia	Milano	1,04
Lombardia	Varese	1,04
Friuli	Udine	1,03
Lombardia	Cremona	1,03
Lombardia	Mantova	1,03
Lombardia	Brescia	1,02
Lombardia	Mantova	1,02

Table 3: Biogas plants with power higher than 1MWe that are working since 30/06/09 - Source GSE

Unlike is the case of plants that recover gas from municipal waste landfills, where the power, even if divided into several engines, is linked to the size of landfills. Recovery facilities already exist with the integration of Otto engines and ORC cycles on thermal discharge of the first.

Plants with power higher than 1MWe counted by GSE (Table 4) are about 80 for a total power of about 190 MWe instead the plants with power of about 3 MWe are about 20.

Only two, among the plants to project have a power higher than 3 MWe.

Regione	Provincia	MWe	Regione	Provincia	MWe
Piemonte	Torino	8,5	Sardegna	Cagliari	1,87
Lombardia	Milano	6,6	Lombardia	Milano	1,86
Campania	Napoli	6,39	Trentino Alto Adige	Trento	1,72
Sicilia	Palermo	6,29	Marche	Ancona	1,7
Liguria	Genova	5,65	Campania	Caserta	1,67
Piemonte	Torino	5,6	Emilia Romagna	Modena	1,67
Lazio	Roma	5,4	Lombardia	Cremona	1,67
Sicilia	Palermo	5,24	Piemonte	Cuneo	1,67
Lazio	Roma	5,2	Veneto	Venezia	1,67
Lazio	Roma	5,15	Veneto	Padova	1,65
Liguria	Savona	4,34	Lombardia	Milano	1,64
Lombardia	Varese	4,16	Veneto	Treviso	1,64
Lazio	Roma	3,75	Puglia	Brindisi	1,56
Lazio	Roma	3,51	Lombardia	Cremona	1,52
Emilia Romagna	Reggio	3,5	Lombardia	Varese	1,5
Sicilia	Messina	3,19	Piemonte	Cuneo	1,46
Toscana	Firenze	3	Veneto	Padova	1,42
Lombardia	Varese	2,88	Toscana	Pistoia	1,35
Liguria	Genova	2,83	Marche	Macerata	1,32
Toscana	Livorno	2,74	Toscana	Pisa	1,3
Sardegna	Campidano	2,71	Lazio	Roma	1,26
Campania	Napoli	2,7	Lombardia	Brescia	1,25
Lombardia	Pavia	2,4	Piemonte	Cuneo	1,24
Piemonte	Novara	2,39	Umbria	Perugia	1,2
Emilia Romagna	Bologna	2,37	Emilia Romagna	Forlì	1,15
Emilia Romagna	Bologna	2,3	Calabria	Catanzaro	1,1
Piemonte	Torino	2,17	Emilia Romagna	Modena	1,1
Abruzzo	Pescara	2,13	Emilia Romagna	Reggio	1,1
Emilia Romagna	Bologna	2,13	Lazio	Latina	1,1
Marche	Ancona	2,13	Lazio	Roma	1,1
Marche	Ancona	2,13	Puglia	Lecce	1,09
Puglia	Taranto	2,13	Campania	Napoli	1,07
Campania	Salerno	2,1	Puglia	Foggia	1,07
Marche	Pesaro/Urbino	2,03	Puglia	Taranto	1,07
Lombardia	Brescia	2	Toscana	Grosseto	1,07
Veneto	Verona	2	Liguria	Savona	1,06
Emilia Romagna	Forlì	1,95	Marche	Ancona	1,05
Lazio	Viterbo	1,9	Puglia	Bari	1,05
Marche	Fermo	1,88	Calabria	Catanzaro	1,02

Table 4: Plants that recover gas from municipal waste landfills with a power higher than 1 MWe that are working since 30/06/09 - Source GSE

Sources:
– www.gse.it

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PLANTS USED BIOLIQUIDS FROM RENEWABLE SOURCES [ATECO 35]

The incentives for electric generation from renewable sources, trough all-inclusive tariff (tariffa omnicomprensiva) (for power less than 1 MWe) or the green certificates, don't consider the different types of biomass (solid, liquid o gas) for establish the value of incentives, but consider only the provenance of biomass (short chain) or the traceability, so crossed the first phase where the attention had been focused on solid biomass, the attention is shifting from the solid biomass to the more efficient technologies and with more simple management; particularly diesel engines fueled by vegetables oils and animal greases.

First of all the colza oil but also the palm oil (that is solid at our room temperature) and it is also hoped the jatropha oil, coming from marginal fields crops, so it isn't an alternative to alimentary crops.For give an idea of the market, GSE was aware of 67 operating (and so stimulated with green incentives or all-inclusive tariff) plants realized between 2008 and June 2009; these plants have a total power of about 500 MWe and others 1500 MWe under construction.

So this is a really potential market. Plants with power of more than 1MWe came into operation between January 2008 and June 2009 and those ones qualified to project on June 30, 2009 (table 5). In both cases the plants with power higher than 3MWe are the majority.

Impianti qualificati in esercizio >1MWe		
Regione	**Provincia**	**MWe**
Campania	Napoli	76,58
Emilia Romagna	Ravenna	58,25
Puglia	Bari	51
Sardegna	Nuoro	36,5
Puglia	Bari	34,15
Emilia Romagna	Ravenna	34
Puglia	Bari	34
Basilicata	Matera	25,6
Puglia	Bari	24,84
Toscana	Livorno	24,77
Puglia	Bari	17
Puglia	Bari	13,07
Puglia	Bari	13
Trentino Alto Adige	Bolzano	10,1
Campania	Salerno	8,79
Lombardia	Pavia	8,69
Trentino Alto Adige	Bolzano	7,45
Emilia Romagna	Ravenna	7,2
Lombardia	Brescia	7,12
Toscana	Lucca	6
Veneto	Vicenza	5,2
Veneto	Padova	4
Sardegna	Agrigento	3,92
Piemonte	Alessandria	3
Umbria	Perugia	2,8
Lombardia	Brescia	2,74
Lombardia	Cremona	1,62
Piemonte	Torino	1,36

Table 5: Plants came in operation on June 30, 2009 fueled by bio liquid with power higher than 1 MWe – source GSE

Sources:
- www.gse.it

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