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INDUSTRIAL PLANTS II

Chapter five (part 2):
Thermal plants

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

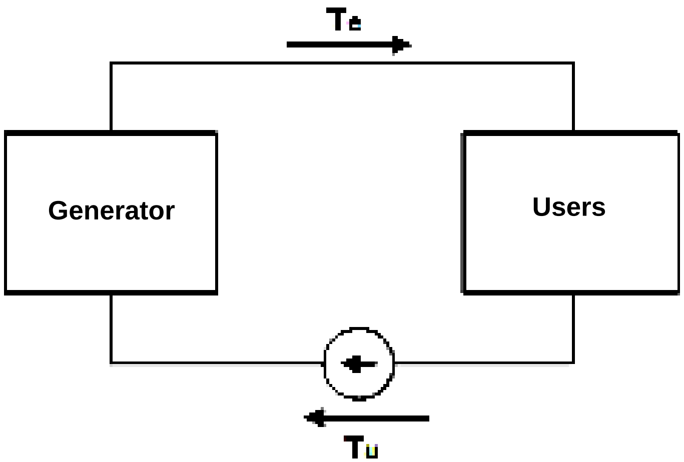
Thermal plants

Production and distribution of thermal energy

The problem is to provide thermal energy to utilities inside the layout of the industrial plant.

The service has the purpose of:

- generate the required heat output over time;
- distribute the thermal power generated, considering the requirements (temperature, pressure) by users.



Thermal plants

<u>Production and distribution of thermal energy</u>

The thermal power is the power generated and transferred that is actually sold to users.

The objective is to be achieved is one that provides for the **minimization of the overall cost of service**. This should take into account:

- **cost of the plant**, consisting of heat generator, pumping system, pipes that connect the generator to the user, heat exchangers, storage tanks etc. This cost if reported per year corresponds to the amortization;
- **cost of operation**, which takes into account the costs in a year of operation is to have the staff, the maintenance, the consumption of electricity, fuel, compressed air, the heat transfer fluid, the servo means minors etc.

Thermal plants

Production and distribution of thermal energy

To influence these costs there are some management tools that need to be considered (flow temperature T_e and return T_u, latent heat of evaporation r, transport velocity v, density ρ and specific heat c of the heat transfer fluid).

The **heat transfer fluid** intermediary between the heat generator and the load in addition to the physical quantities should be considered

- easy to handle;
- non-toxic;
- readily available;
- economic;
- chemically stable;
- high density;
- transported at high speeds;
- with good thermal capacity;
- equipped with good ability to convective exchange.

Production and distribution of thermal energy

The thermodynamic quantities of the various heat transfer fluids are shown in table

Heat transfer fluid[1]	Air at 75°C	Water at 75°C	Water at 8 bar	Saturated steam at 5 bar	Thermal oil [2]
Density (kg/m^3)	1	975	918	2,61	1,06
Specific heat (kJ/kg °C)	1,004	4,184	4,184	2,008	1,841
Latent heat of evaporation (kJ/kg)	-	-	-	≈ 500	-
Transport speed (m/s)	40	2 – 4	2 – 4	40 – 50	0,1 – 0,5
Convection coeffi-cient (kJ/m^2°C h)	83,68–167,36	836,8 – 418.400	836,8 – 418.400	167.360*	41,84 – 83,68
Flow temperature (°C)	75	75	150	151	300

* in transition state

Thermal plants

Production and distribution of thermal energy

Whereas a cold fluid (user) water and a wall of heat exchange in sheet steel, the heat exchange air is minimal (assumed = 1), intermediate that of water (200) and that of the maximum steam (800).

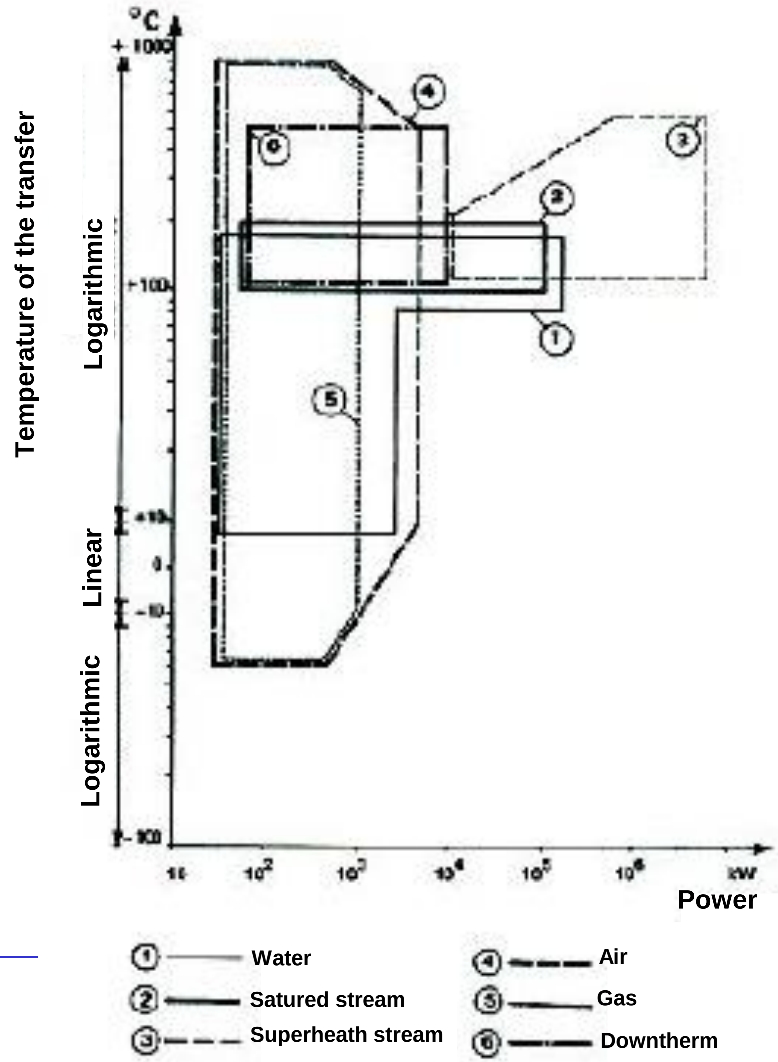
The fluid transfer used in most applications is the steam. As the pressure of the vapor improve its characteristics of exchange, but increase the cost of the particular subjected to mechanical action. Consequently, typical pressures of realization does not exceed the 20 bar.

Alternatively you use heat transfer fluids (orthodichlorobenzene, dowtherm, mineral oils etc.).

Thermal plants

Production and distribution of thermal energy

The field of application of some heat transfer fluids are :



Production and distribution of thermal energy

Production and distribution of thermal energy:

- heat transfer fluid or transfer, with particular reference to its nature, to the speed etc.

  In selecting the fluid transfer, there may be two cases:

a) fluid that works not exploiting the phase transition

   The thermal power output transferred to the user Q_u is defined by:

$$Q_u = G \cdot c \cdot \Delta T = (\rho \cdot v \cdot 3600 \cdot A) \cdot c \cdot \Delta T \quad (W)$$

   where:

   G = mass flow of heat transfer fluid kg/h);

   ρ = density of the heat transfer fluidkg/m^3);

   v = velocity of the heat transfer fluid (m/s);

   A = section of passage of the heat transfer fluid (m^2);

   c = specific heat of the heat transfer fluid (J/kg °C);

   ΔT = temperature difference between flow T_e and return T_u of the heat transfer fluid (°C).

Production and distribution of thermal energy

Production and distribution of thermal energy:

- heat transfer fluid or transfer, with particular reference to its nature, to the speed etc.

In selecting the fluid transfer, there may be two cases:

b) fluid that works exploiting the phase transition

The thermal power output transferred to the user Q_u is defined by:

$$Q_u = G \cdot (c \cdot \Delta T + r) = (\rho \cdot v \cdot 3600 \cdot A) \cdot (c \cdot \Delta T + r) \quad \text{(W)}$$

where:

G = mass flow of heat transfer fluid kg/h);

ρ = density of the heat transfer fluidkg/m^3);

v = velocity of the heat transfer fluid (m/s);

A = section of passage of the heat transfer fluid (m^2);

c = specific heat of the heat transfer fluid (J/kg °C);

ΔT = temperature difference between flow T_e and return T_u (°C);

r = latent heat of evaporation of the heat transfer fluid (J/kg).

Thermal plants

Production and distribution of thermal energy

Production and distribution of thermal energy:

- heat transfer fluid or transfer, with particular reference to its nature, to the speed etc.

  In selecting the fluid transfer, there may be two cases:

b) fluid that works exploiting the phase transition

   This relationship is justified in the hypothesis that the user is able to also exploit the latent heat of evaporation of the heat transfer fluid, which can be obtained with the use of heat exchangers specific

Thermal plants

Production and distribution of thermal energy

Ultimately, to increase the useful thermal output of the heat generator is to be had in the heat transfer fluid having a high density, which allows high-speed distribution, which has a high thermal capacity and chemical stability such as to obtain high discharge temperatures T_e.

Production and distribution of thermal energy

Since the useful thermal power Q_u is conveyed from the heat transfer fluid to the user, this has yet to be exchanged in a heat exchanger, for which it is:

$$Q_u = K \cdot S \cdot \Delta\theta_{ml} \ \text{(W)}$$

where:

K = overall heat transfer coefficient (W/m^2 °C), defined by:

$$K = \frac{1}{\frac{1}{\alpha_c} + \frac{s}{\lambda} + \frac{1}{\alpha_f}}$$

α_c = exchange coefficient of convective heat transfer fluid heat (W/m^2 °C);

s = thickness of the wall of the heat exchange (m);

λ = thermal conductivity of the wall of exchange (W/m °C);

α_f = coefficient of convective exchange cold fluid (W/m^2 °C);

S = exchange surface of the heat exchanger (m^2);

Production and distribution of thermal energy

Since the useful thermal power Q_u is conveyed from the heat transfer fluid to the user, this has yet to be exchanged in a heat exchanger, for which it is:

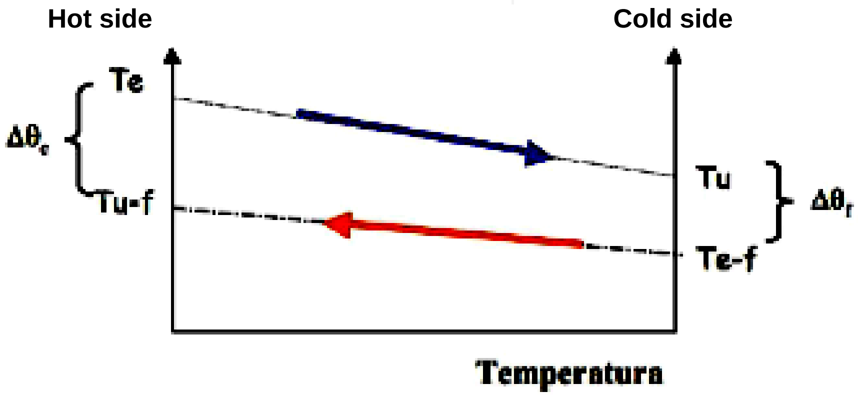
$$Q_u = K \cdot S \cdot \Delta\theta_{ml} \ \ (W)$$

where:

$\Delta\theta_{ml}$ = variation mean temperature logarithmic, defined by the relation (figure relative to a heat exchanger in countercurrent):

$$\Delta\theta_{ml} = \frac{(\Delta\theta_c - \Delta\theta_f)}{\ln\left(\frac{\Delta\theta_c}{\Delta\theta_f}\right)}$$

$\Delta\theta_c$ = difference of temperature between the inlet temperature of the hot heat transfer fluid and output of the fluid used by the user $T_e - T_{u\text{-}f}$ (°C)



Thermal plants

Production and distribution of thermal energy

This allows you to say that you will try of the heat transfer fluids with high exchange coefficients thermo-convective (α_c, α_f) and heat exchangers with large exchange surface, high coefficient of heat conductive and limited thickness of the wall of exchange.

Production and distribution of thermal energy

For convey the useful thermal power Q_u are requires two machines:

- pump for conveying the heat transfer fluid from the heat generator to the user, which has a nominal power P_n detectable by:

$$P_n = \frac{V \cdot H}{\eta_{pompa}}$$

where:

V = volumetric flow rate of the heat transfer fluid (m^3/s);

H = head of the pump such as to overcome the loss of load localized and distributed (N/m^2);

η_{pompa} = pump efficiency;

Production and distribution of thermal energy

For convey the useful thermal power Q_u are requires two machines:

- heat generator for heating the heat transfer fluid

  Taking into account of the ideal energy requirement Q_h, of the losses along the distribution network from the heating to the thermal zones and of the any loss of issuance and regulation and control in the case of space heating, it is seen that it is possible to determine the thermal energy that leave the central itself Q_u.

  The thermal energy produced Q_n ecessary for transfer at the user the his request Q_u must take account of the electricity consumed by the pump Q_p and performance of this operating machine η_p:

$$Q_n = Q_u + Q_p \cdot \eta_p$$

  The contribution of the term $Q_p \cdot \eta_p$ is very small order of 1%.

Production and distribution of thermal energy

For convey the useful thermal power Q_u are requires two machines:

- heat generator for heating the heat transfer fluid

From the thermal energy produced Q_n is possible to obtain the primary energy consumed Q_c that is equal to:

$$Q_c = \frac{Q_n}{\eta_{tu}} = \frac{Q_h}{\eta_{tu} \cdot \eta_e \cdot \eta_c \cdot \eta_d}$$

where:

η_{tu} = thermal efficiency of the heat generator, which represents its average performance in the time period (month or semi-stationary method for the season in the stationary method A) and that depends on the type of generator and how it is used.

Production and distribution of thermal energy

For convey the useful thermal power Q_u are requires two machines:

- heat generator for heating the heat transfer fluid

  Known the value of the primary energy consumed Q_c, you can determine the primary energy demand required for heating throughout the season Q through the relationship previously seen:

$$Q = Q_c + \frac{Q_{aux}}{\eta_{sen}} = Q_c + \frac{Q_p + Q_b}{\eta_{sen}}$$

where:

Q_c = energy associated with the fuel burned in the heat generator (primary energy); Q_{aux}= electric energy for auxiliaries (pumps, fans, etc.). It is smaller of Q_c for radiator systems and radiant panels (1-2%), while it can be significant for fan coil systems for heating and air); η_{sen}= yield of the electricity service national, that the rule sets 0.36. It takes into account the conversion of fuel energy to electrical energy; Q_p = electric energy supplied to the circulation pump of the heat transfer fluid; Q_b = electric energy supplied to the burner.

Thermal plants

Production and distribution of thermal energy in una realtà industriale

The evaluation of thermal loads winter of a specific industrial reality has been prepared previously. To cope at the heat needs has been made for the installation of 8 unit heaters with heat outputs from 17.7 kW and installed on the wall (Figure), which make up for the required heat output of 137.4 kW, and for which is provided to the supply of hot water 85-75°C, a temperature drop of 10°C and consequently a Δt_m of 65°C with an air inlet temperature of 15°C. The diameter of the inlet and outlet of the heated water is 1½" corresponding to 38.1 mm.

Production and distribution of thermal energy in una realtà industriale

The mass flow rate of the heat transfer fluid inherent in a unit heater is equal to:

$$\dot{M} = \rho \cdot v \cdot \frac{\pi \cdot d^2}{4} = 969 \cdot 1 \cdot \frac{\pi \cdot 0{,}0381^2}{4} \cdot 3600 = 3977{,}1 \; kg/h$$

where:

ρ = density of water at the flow temperature (85°C) = 969 kg/m^3;

v = velocity of water = 1 m/s;

d = internal diameter of the pipe = 0,0381 m.

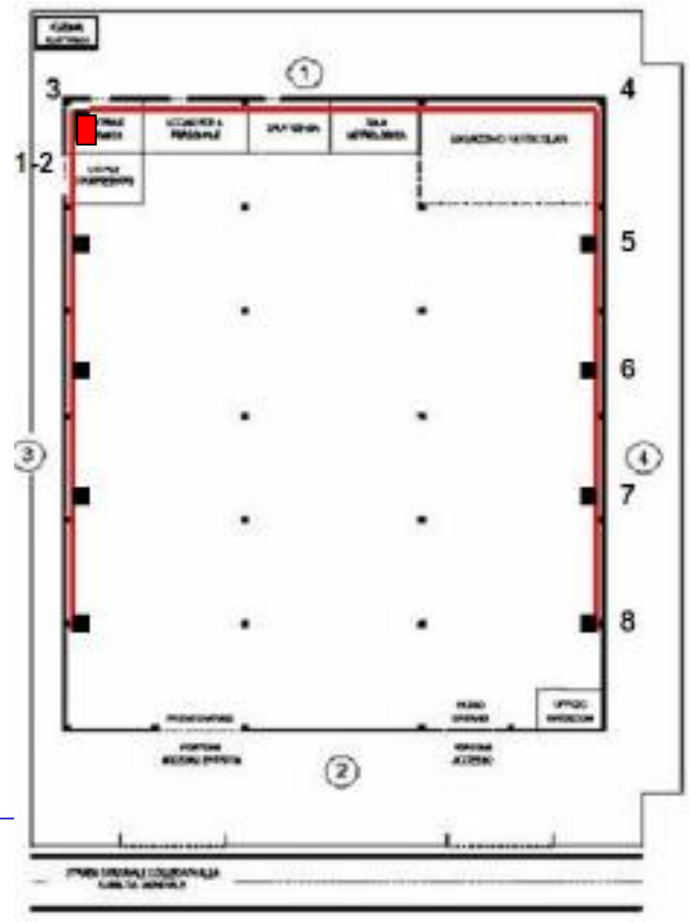
Thermal plants

Production and distribution of thermal energy in una realtà industriale

In according to the thermal power of the generator (150 kW to take account of the dispersions to the mantle and for ventilation, and taking into account a margin of safety) and at the temperature of hot water supply (85-75°C), you choosing a condensing boiler with gas powered modulating burner (from 30% to 100% of the load).

Production and distribution of thermal energy in una realtà industriale

Known the scheme of the plant (figure), one must calculate the total pressure loss necessary for the dimensioning of the pump so as to ensure the flow rate at the air heater more farther.



Production and distribution of thermal energy in una realtà industriale

The total pressure loss is the sum of the pressure drops (depending on the size and length of the pipes) and those accidental (resistors for geometrical singularity, bends, valves etc.).

In table by branch of interest underdog you consider the length of the pipe, considering the elevation in height, and the doubles to take account of both the outward journey that the water return.

Branch	Flow (kg/s)	Lenght (m)	Diameter d (mm)	DN (mm)	Pressure drop continues ($m_{C.A.}$)	Actual speed (m/s)	Pressure drop localized ($m_{C.A.}$)	Pressure drop total ($m_{C.A.}$)
1 – 2	8,08	5	0,0912	100	0,053	0,95	1,424	1,477
2 – 3	4,04	5	0,0729	80	0,066	0,92	0,087	0,153
3 – 4	4,04	56	0,0729	80	0,740	0,92	0,028	0,768
4 – 5	4,04	13	0,0729	80	0,172	0,92	0,028	0,200
5 – 6	3,03	13	0,0631	65	0,234	1,06	0,189	0,423
6 – 7	2,02	13	0,0515	50	0,338	1,09	0,234	0,572
7 – 8	1,01	14	0,0364	40	0,276	0,85	0,088	0,364
Totale					1,879		2,078	3,957

Production and distribution of thermal energy in una realtà industriale

You consider the scope of each branch and you calculate the diameter remembering that:

$$d = \sqrt{\frac{4 \cdot \dot{M}}{\rho \cdot \pi \cdot v}}$$

The previous table shows the nominal diameter closer to the value obtained for galvanized steel pipes. In the same, are also reported losses distributed per unit length J calculated with the formula of Marchetti:

$$J = 12 \cdot 10^{8} \cdot \frac{Q^{1,83}}{d^{4,83}}$$

having expressed the water flow rate Q in dm3/s and the diameter d of the pipe in mm.

The share geodesic is not computed as the circuit is closed.

Production and distribution of thermal energy in una realtà industriale

For localized pressure losses, the calculations are based on the coefficient of loss of load localized ξ, which represents the sum of all the localized losses of the piping in question, even if the tables provide the equivalent pipe length or the localized loss of pressure due to valves, gate valves, bends, T, variations in section etc. (table)

DN	Bends			Fittings		Gate valves	Ceck valves
	45°	90°	90° Large radius	T	Cross		
	Equivalent pipeline length (m)						
25	0,3	0,6	0,6	1,5	1,5	-	1,5
32	0,3	0,9	0,6	1,8	1,8	-	2,1
40	0,6	1,2	0,6	2,4	2,4	-	2,7
50	0,6	1,5	0,9	3,0	3,0	0,3	3,3
65	0,9	1,8	1,2	3,6	3,6	0,3	4,2
80	0,9	2,1	1,5	4,5	4,5	0,3	4,8
100	1,2	3,0	1,8	6,0	6,0	0,6	6,6
125	1,5	3,6	2,4	7,5	7,5	0,6	8,3
150	2,1	4,2	2,7	9,0	9,0	0,9	10,4
200	2,7	5,4	3,9	10,5	10,5	1,2	13,5
250	3,3	6,6	4,8	15,0	15,0	1,5	16,5
300	3,9	8,1	5,4	18,0	18,0	1,8	19,5

Production and distribution of thermal energy in una realtà industriale

The nominal power P_n is:

$$P_n = \frac{V \cdot H}{\eta_{pompa}} = \frac{8{,}84 \cdot 3993}{0{,}9 \cdot 1000} = 39{,}2 \ kW$$

where:

V = volumetric flow rate of the heat transfer fluid = 8,84 m^3/s;

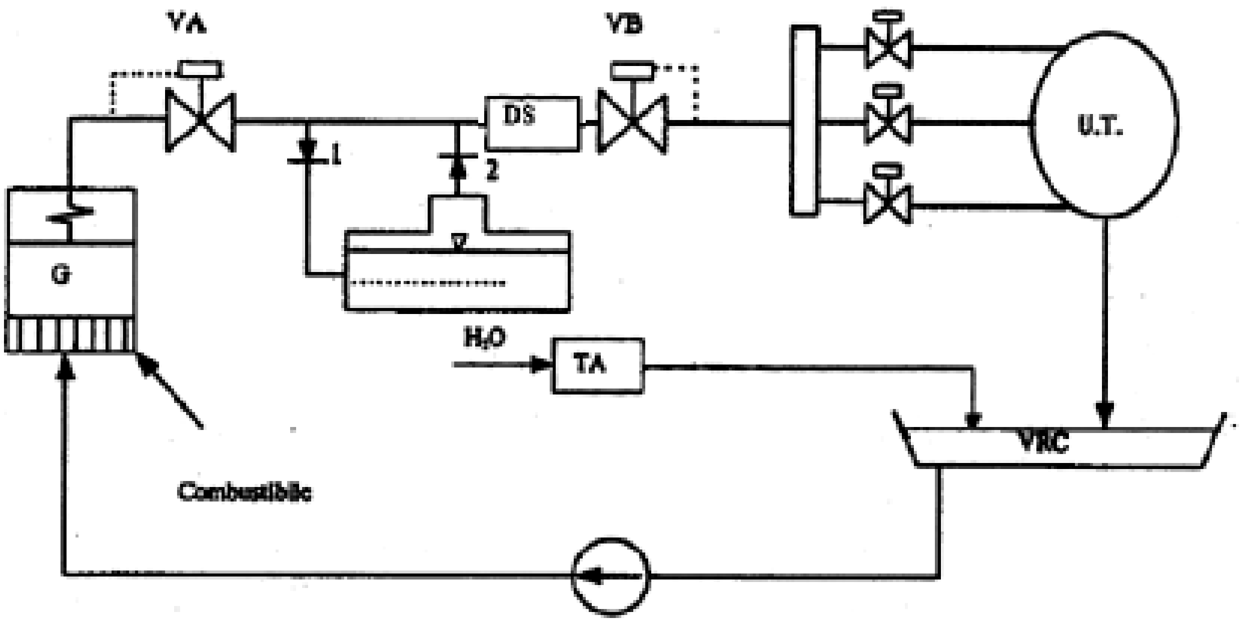
H = head of the pump such as to overcome the loss of load localized and distributed = 3993 bar;

η_{pompa} = pump efficiency = 0,9.

Thermal plants

Plant of production and distribution of the steam

The plant of production and distribution hot water does not present particular problems, while the steam, widely used in the industrial, particular attention is given and you returns below its sizing. The scheme of plant is shown in figure



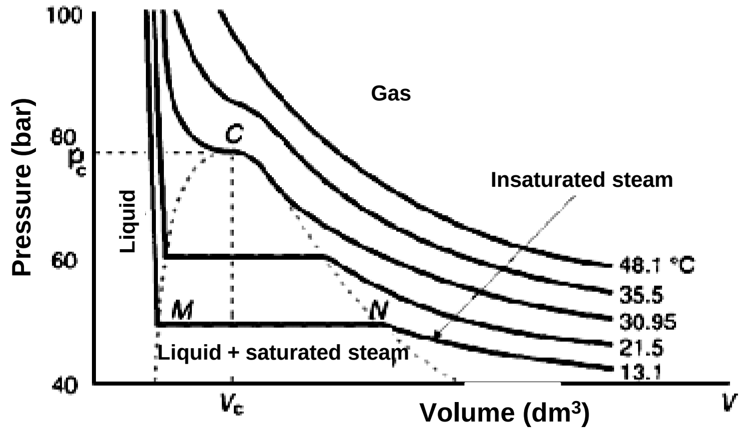
Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**) in which there is the transformation from low temperature water in the first wet saturated steam, dry saturated, and finally superheated

  This transformation in the three planes thermodynamic provides:

  a) *plan of Clapeyron* – pressure-volume (curve Andrews): there is a transformation constant pressure with increase in the volume where it has the transition from liquid phase to the phase transition between the liquid and the saturated vapor, and steam overheated;



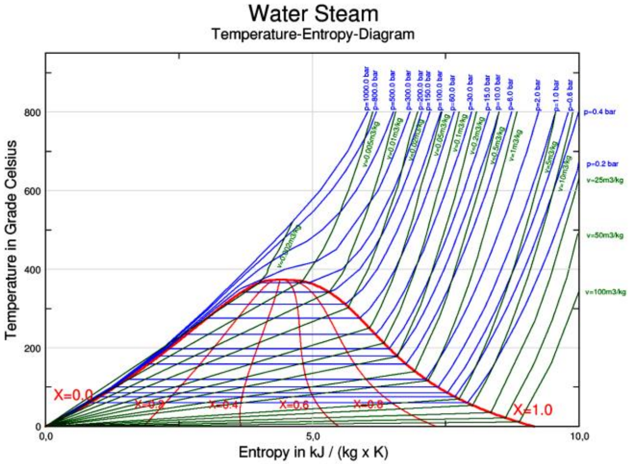
Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  This transformation in the three planes thermodynamic provides:

  b) *plan entropic* – temperature-entropy: it has a transformation that provides for an increase of the temperature and the entropy (liquid), a constancy of temperature and entropy increase (phase transition between the liquid and the saturated vapor) and an increase of temperature and entropy (superheated steam);



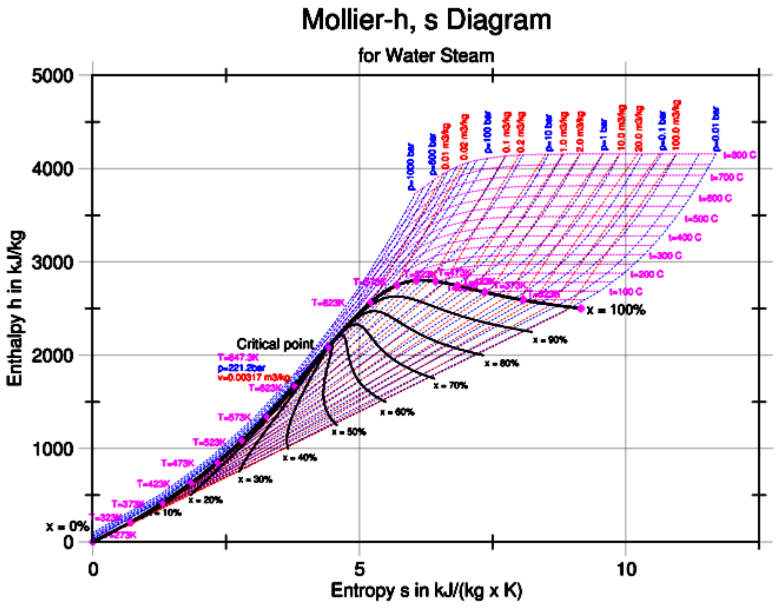
<u>Plant of production and distribution of the steam</u>

The plant consists of:

- **a steam generator** (**G**)

  This transformation in the three planes thermodynamic provides:

  c) *<u>plan enthalpic</u>* – enthalpy-entropy: it has a transformation that provides always increase in enthalpy and entropy in the transition from liquid phase to the phase transition between the liquid and the saturated steam, and superheated steam



Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  The steam generator has the purpose, with the burner, burning the fuel with an excess of air, of to direct the flames of combustion to the tube bundle of evaporation, collecting and directing the products of combustion at high temperature prior to the superheater, which will bring the saturated steam generated in overheated, and, then, the economizer in so that the flue gas, impoverished of their enthalpic content, can be used to heat the water circulating in the tube bundles of evaporation, thus increasing the efficiency of the generator and preventing formation of cracks in the process of hardening of the tube bundle.

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

The chemical reactions which underlie the combustion process are:

$$C + O_2 \rightarrow CO_2$$ **with the development of** 32.615,2 kJ/kg$_C$

$$CO_2 + C \rightarrow 2\,CO$$ **with the development of** 9.204,8 kJ/kg$_C$

While the first reaction is an ideal combustion, the second is unfavorable because the carbon monoxide is toxic and, to avoid formation, must ensure that the combustion reaction takes place with excess of air compared to stechiometric values.

In the process of combustion is also another major reaction:

$$2\,H_2 + O_2 \rightarrow 2\,H_2O$$ **with the development of** 12.694,3 kJ/Nm$^3{}_H$

Thermal plants

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  Nel caso in cui l'acqua formatasi vaporizza, perde il suo calore latente di evaporazione, e poi questo porta alla differenziazione tra potere calorifico superiore e inferiore di un combustibile (tabella)

Calorific	upper	lower
Solid/liquid fuel	MJ/kg	MJ/kg
Dry wood (humidity < 15%)	-	15,9
Coal	-	31,4
Diesel fuel	44,0	41,0
Gas fuel	MJ/Nm^3	MJ/Nm^3
Methane	35,16	31,65

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  The combustion is said stechiometric when it is conducted with amount of O_2 such to respect the stechiometry (mass balance) of the total oxidation reaction. In the case of real combustion, the air is in excess respect the stechiometry to ensure the optimal reaction conditions (presence of O_2 in an amount adequate to completely oxidize the fuel throughout the combustion volume). For which the excess air is the percentage of air supplied in excess of the stoichiometric amount and increases with the difficulty of contact fuel/combustion air. Therefore in the gas there is an excess of air of 10-15%, around 20% in liquids and solids of 20-40%. A part of the combustion of the non-traditional fuels, such as municipal solid waste which require an excess of air between 80 and 150%.

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  It thus defines the **index of air** I_A defined by the equation:

$$I_A = \frac{actual\ air}{stechiometric\ air} = \frac{stechiometric\ air + air\ in\ excess}{stechiometric\ air}$$

Known the fuel composition, is evaluated stechiometric air and fumes. Known the index of air, you calculate the actual fumes:

$$Anctual\ \ fumes = stechiometric\ \ fumes + air\ in\ excess$$
$$Actual\ \ fumes = stechiometric\ \ fumes + (I_A - 1) \cdot air\ stechiometric$$

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  The table shows the values of the index of air and flue gas actual volume of some fuels under normal conditions.

Fuel	Index of air	Actual volume of fumes (m^3/MJ)
Coal	1,2 – 1,3	0,287 – 0,335
Oil fuel	1,1 – 1,2	0,287 – 0,311
Diesel fuel	1,1 – 1,2	0,263 – 0,287
Methane	1,1	0,287
Municipal solid waste	1,8 – 2,2	0,526 – 1,052

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  By increasing the excess air, it generates a trade-off, which on one side leads to an improvement in combustion, even if it disperses heat given that in the combustion chamber reaches a greater amount of cold air and are experiencing greater losses in the hot fumes evacuated.

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  The thermal power made available by the generator Q_g is:

$$Q_g = G_c \cdot H_{ic} \cdot \eta_g \ (W)$$

where:

G_c = amount of fuel consumed (kg/h o Nm^3/h);

H_{ic} = lower heating value of fuel (kJ/kg o kJ/Nm^3);

η_g = efficiency of the steam generator, defined by the relation:

$$\eta_g = 1 - \frac{P\%_{incombusti} + P\%_{irraggiamento} + P\%_{fumi}}{100}$$

$P_{\%incombusti}$ = percentage loss due to incomplete combustion and non-oxidized, and the presence of combustion residues (e.g. ash); $P_{\%irraggiamento}$ = percentage loss due to radiation in the combustion chamber and which must be evaluated experimentally; $P_{\%fumi}$ = percentage loss due to the presence of fumes and therefore a function of the flow rate and temperature of the fumes evacuated.

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  $P_{\%fumi}$ = percentage loss due to the presence of fumes and therefore a function of the flow rate and temperature of the fumes evacuated. It can be expressed by the relationship :

  $$P\%_{fumi} = \frac{c_f \cdot \left[\alpha_{st} \cdot \left(1 + \frac{\varepsilon}{100} \right) + f \right] \cdot \Delta T_{fa}}{H_{ic}}$$

  with:

  c_f = specific heat of fumes (kJ/kg °C o kJ/Nm^3);

  α_{st} = stoichiometric ratio air-fuel;

  ε = excess air;

  f = fuel fraction gasified;

  ΔT_{fa} = temperature difference between the flue exhaust and the air inlet (°C);

  H_{ic} = lower calorific value of the fuel (kJ/kg o kJ/Nm^3);

Thermal plants

<u>Plant of production and distribution of the steam</u>

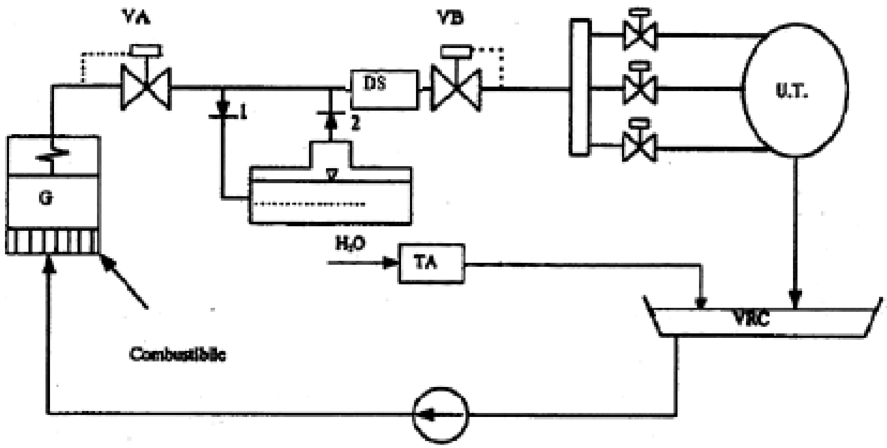
The plant consists of:

- **a steam generator** (**G**)

  In this generation system, free of vapor to accumulate, it is very important to the regulation of:

  a) ***steam flow rate***

  This adjustment is related to the fact that the user request is variable in time. It is therefore necessary, in the limits of the elasticity of the steam generator, regulate the activity depending on the actual instantaneous required and this can be achieved by adjusting the valve VA (VB valve is not present in this configuration),



Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  In this generation system, free of vapor to accumulate, it is very important to the regulation of:

  a) ***steam flow rate***

  In fact, when the user demand grows, it grows the pressure drop between upstream and downstream, in this case the valve opens, empties the tank containing water in equilibrium with the steam present in the boiler in the upper body. At this point the sensors react by increasing the flow rate of fuel and thus heat, and it is to restore the balance between the demand (required steam) and the offer (steam production);

Plant of production and distribution of the steam

The plant consists of:

- **a steam generator** (**G**)

  In this generation system, free of vapor to accumulate, it is very important to the regulation of:

  b) temperature of the steam

  In this case, the generated amount of superheated steam is not compatible with the user requirements, it is possible to insert a mixture desuperheater (DS). The transformation is isentropic for which you can write the energy balance:

$$G_e \cdot i_e + G_a \cdot i_a = G_u \cdot i_u$$

  G_e = mass flow of steam superheated at the entrance of the desuperheater (kg/h); i_e = superheated steam enthalpy at the entrance of the desuperheater(kJ/kg); G_a = mass flow rate at the entrance of the desuperheater (kg/h); i_a = enthalpy of desuperheating at the entrance of the desuperheater (kJ/kg); G_u = mass flow of steam superheated at the exit of the desuperheater (kg/h); i_u = superheated steam enthalpy at the exit of the superheater (kJ/kg).

Plant of production and distribution of the steam

The plant consists of:

- **control valves** (VA and VB), that are regulated at a given pressure, in such a way as to modulate the delivery following the variability of the user request;
- **condensate collection tank** (VRC), which presents the typical conditions of 80°C and pressure of ambient temperature;
- **water treatment** (TA), such as to provide for the demineralization of makeup water and the prevention of fouling and consequent reductions in exchange coefficients;
- **water circulation pump** to the steam generator and such to win with its prevalence the system head loss;
- **accumulator lung**, in which steam and superheated water are in thermodynamic equilibrium between them and which is convenient to introduce it when the variability of the loads required is high and when the elasticity of the generator is particularly low.

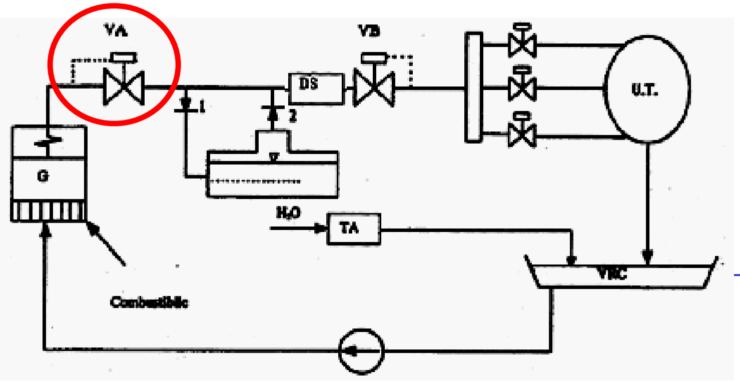
Thermal plants

Plant of production and distribution of the steam

When the variability of the required of the system is high and the elasticity of the generator is particularly low, it can be convenient to introduce a lung accumulator.

In accumulation phase:

- the pressure upstream of the regulation valve V_A salt and the valve opens;
- the steam produced gurgles in the water present in the accumulator;
- the steam condenses, giving up its latent heat. In this way the temperature rises, as well as the level of liquid water;
- a new thermodynamic equilibrium is formed between the heated water and its vapor, with consequent increase of pressure.

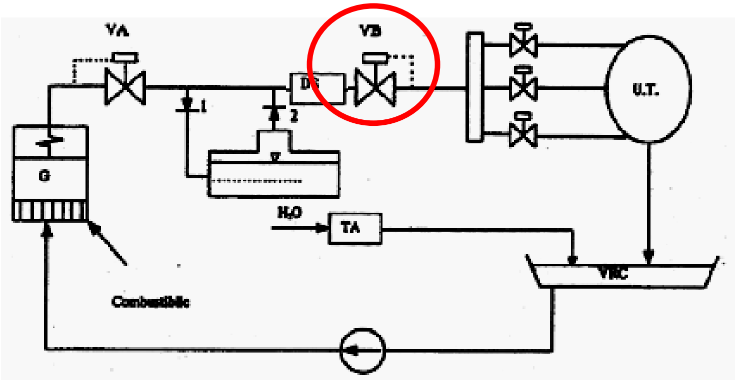


Thermal plants

Plant of production and distribution of the steam

In the emptying phase the process is the reverse:

- the pressure upstream of the regulation valve V_B drops and the valve opens;
- the vapor present in the accumulator exits, breaking the thermodynamic equilibrium;
- to restore this balance, part of the water evaporates;
- they will consequently lower the temperature, pressure and water level inside the accumulator.



Plant of production and distribution of the steam

In these conditions is valid the relation:

$$p_g > p_{max} > p_{min} > p_u$$

where:

p_g = pressure of the steam generator;

p_{max} = maximum pressure supported by the accumulator;

p_{min} = minimum pressure supported by the accumulator;

p_u = pressure required by the user.

With increasing of the p_{max} decreases the volume of the accumulator, increases the cost of the realization for the greater robustness of the storage system and that of the generator as it grows p_g.

Plant of production and distribution of the steam

The maximum pressure p_{max} is comprised between 15 and 18 bar, while compared to the minimum that is the empirical relation:

$$p_{max} = (2 \div 3) \cdot p_{min}$$

Plant of production and distribution of the steam

To size the accumulator of steam you must quantify:

a) mass of steam accumulated

Considering the energy balance of the accumulator you can write a relation:

$$G_{in} \cdot i_{in} = G_{ou} \cdot i_{ou}$$

where:

G_{in} = mass of steam introduced into the accumulator during the accumulation phase (kg);

i_{in} = enthalpy of the steam entered into the accumulator during the accumulation phase (kJ/kg);

G_{ou} = mass of steam transferred into the accumulator during the emptying phase (kg);

i_{ou} = enthalpy of the steam transferred into the accumulator during the emptying phase (kJ/kg).

Plant of production and distribution of the steam

To size the accumulator of steam you must quantify:

a) mass of steam accumulated

Obviously $i_{ou} < i_{in}$ and this implies the presence of a water replenishing system, while in case of non-adiabatic accumulator you need a water purge system.

The mass of accumulated steam G_a is:

$$G_a = \frac{G_{in} \cdot r}{c_v \cdot (T_1 - T_2) \cdot \eta}$$

where:

G_{in} = mass of steam introduced into the accumulator during the accumulation (kg);

r = average latent heat of the steam in the emptying phase (kJ/kg);

c_v = average specific heat of the steam in the emptying phase (kJ/kg);

T_1 = water temperature in saturation conditions at maximum pressure p_{max} (°C);

T_2 = water temperature in saturation conditions at minimum pressure p_{min} (°C);

η = performance of accumulator having regard to its non-adiabatic conditions;

Plant of production and distribution of the steam

To size the accumulator of steam you must quantify:

b) energy storable Ea

This energy is defined by the relationship:

$$E_a = \delta \cdot \eta \cdot c_v \cdot V \cdot (\rho_1 \cdot T_1 - \rho_2 \cdot T_2)$$

where:

δ = fill factor of the accumulator = 0,9;

η = performance of accumulator having regard to its non-adiabatic conditions;

c_v = average specific heat of the steam in the emptying phase (kJ/kg);

V = accumulator volume (m^3);

T_1 = water temperature in saturation conditions at maximum pressure p_{max} (°C);

ρ_1 = density of the liquid in conditions of maximum pressure p_{max} (kg/m^3);

T_2 = water temperature in saturation conditions at minimum pressure p_{min} (°C);

ρ_2 = density of the liquid in conditions of minimun pressure p_{min} (kg/m^3).

Thermal plants

Central heat

It is the room where are installed all or part of the thermal plants for thermal energy production.

Thermal plants

Central heat

These systems are characterized by:

- fuel preparation for sending to the burner;
- generation of heat;
- preparation, storage, treatment, and placing the heat transfer fluid in the transfer circuit from the generator to the user;
- purification of gaseous and liquid effluents;
- ontrol, regulation and measurement of the functional quantities (pressure, temperature, flow rates etc.).

Thermal plants

Central heat

Referring to the case study, in central heat are:

- a condensing boiler to modular operating powered to gas, that satisfies the thermal power required

  The boilers are able to obtain very high yields due to the latent heat recovery of condensation of water vapor contained in the fumes, as well as reductions of the emissions of nitrogen oxides (NO_x) and carbon monoxide (CO), which can reach 70% compared to traditional systems.

  The condensing boiler can recoup some of the latent heat contained in the flue gas before ejecting the fireplace. The particular condensation technology allows to cool the fumes until they return to the state of saturated liquid (in some cases at wet steam), with a recovery of heat used to preheat the return water from the plant.

<u>Central heat</u>

Referring to the case of the previous paragraph study, in the central heat are present:

- <u>a condensing boiler to modular operating powered to gas, that satisfies the thermal power required</u>

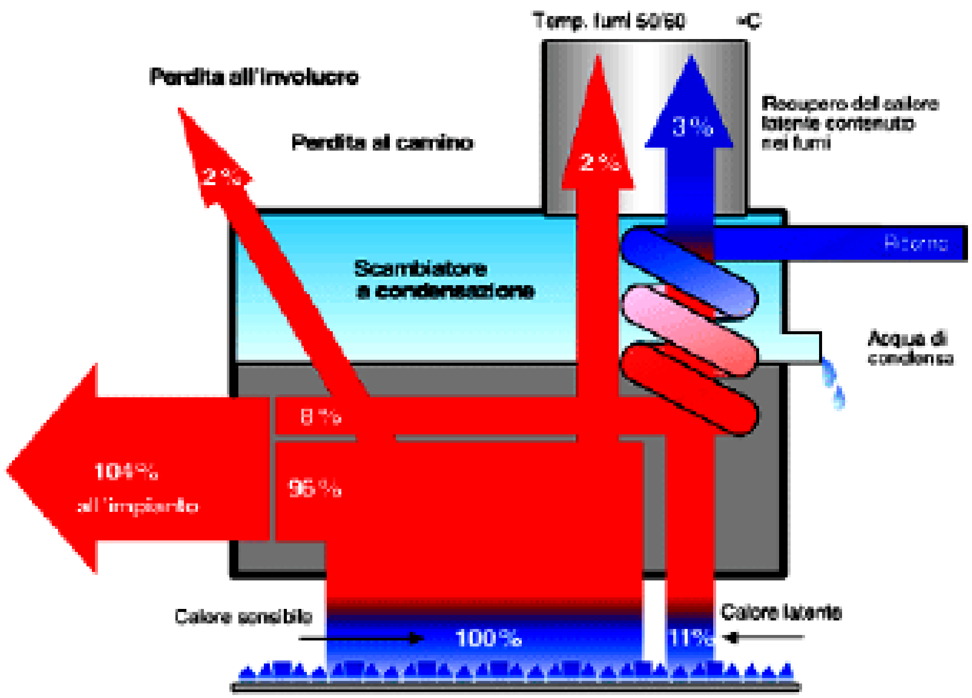
  In this way the temperature of the outlet fumes (which is lowered up to 50-60°C) always keeps the same value of the water delivery temperature, well bottom and then to 140-160°C of the high-efficiency generators and to 200-250°C of the traditional type generators. The low-temperature discharged fumes does not allow the natural draft of the chimney and should be expelled thanks to the prevalence of a ventilator of the boiler and the fumes line in the pressure that must be perfectly airtight

Thermal plants

<u>Central heat</u>

Referring to the case of the previous paragraph study, in the central heat are present:

- <u>a condensing boiler to modular operating powered to gas, that satisfies the thermal power required</u>



Central heat

Referring to the case of the previous paragraph study, in the central heat are present:

- a condensing boiler to modular operating powered to gas, that satisfies the thermal power required

  Given the low temperature of the flue gas condensing boiler, you may use a fireplace in polypropylene, in order to avoid problems of corrosion of the tubes due to acid condensation. It requires a pipe for water drainage of acid condensation, which is formed during operation and which conveys it into a collection pan. There are provided two disposal plants: one for remove condensation from the boiler and one to remove the condensate from the exhaust system of the fumes.

Central heat

Referring to the case of the previous paragraph study, in the central heat are present:

- circulation pumps and collectors of hot water storage
- water treatment plant, which involves a water softening system to 0°F and a dosage of an scale hinibitor product, anticorrosive biocide and compensator pH (values between 7 and 8);
- control room for monitoring and control of thermal and electrical plant.

Thermal plants

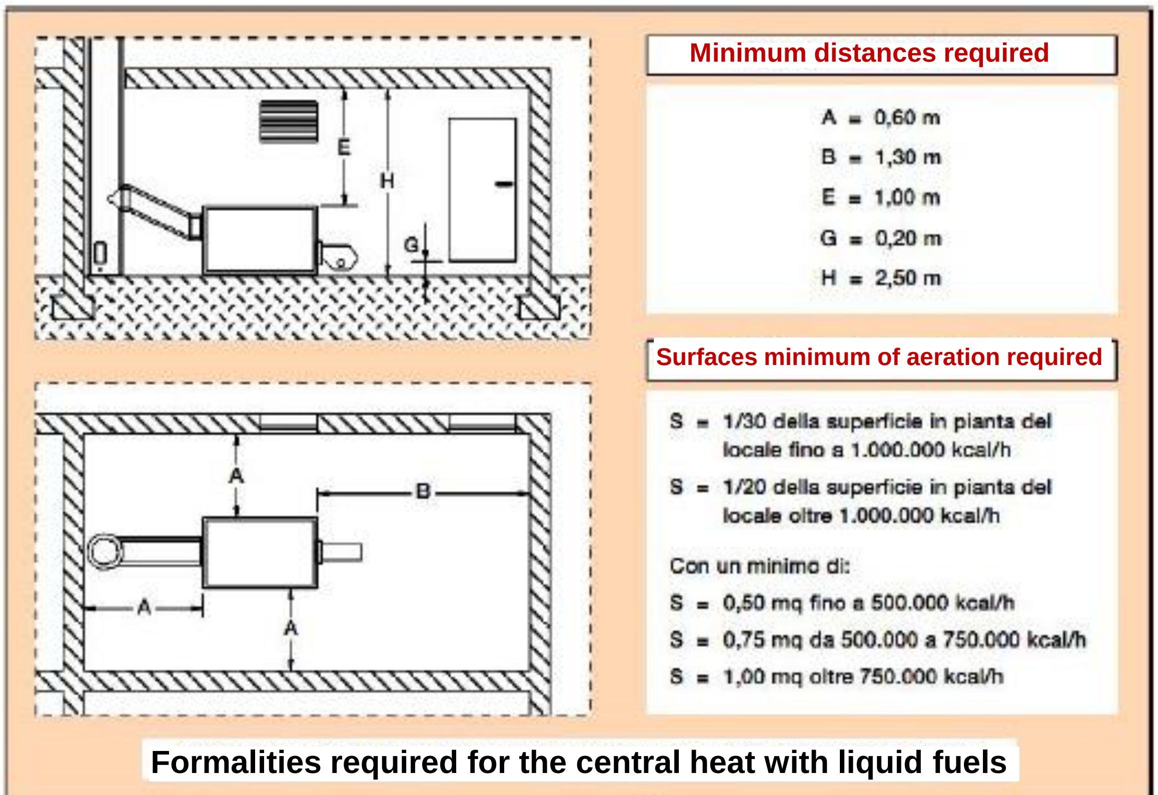
Central heat

The existing rules on the requirements, affecting the production of the heat, are contained in Legislative Decree no. 152/2006 and D.M. 12 April 1996, concerning the production of heat:

- the central heat;
- the characteristics of the chimney and smoke channel;
- the tanks for liquid fuels;
- the burner feeding system;
- the ancillary equipment and devices indicators.

Central heat

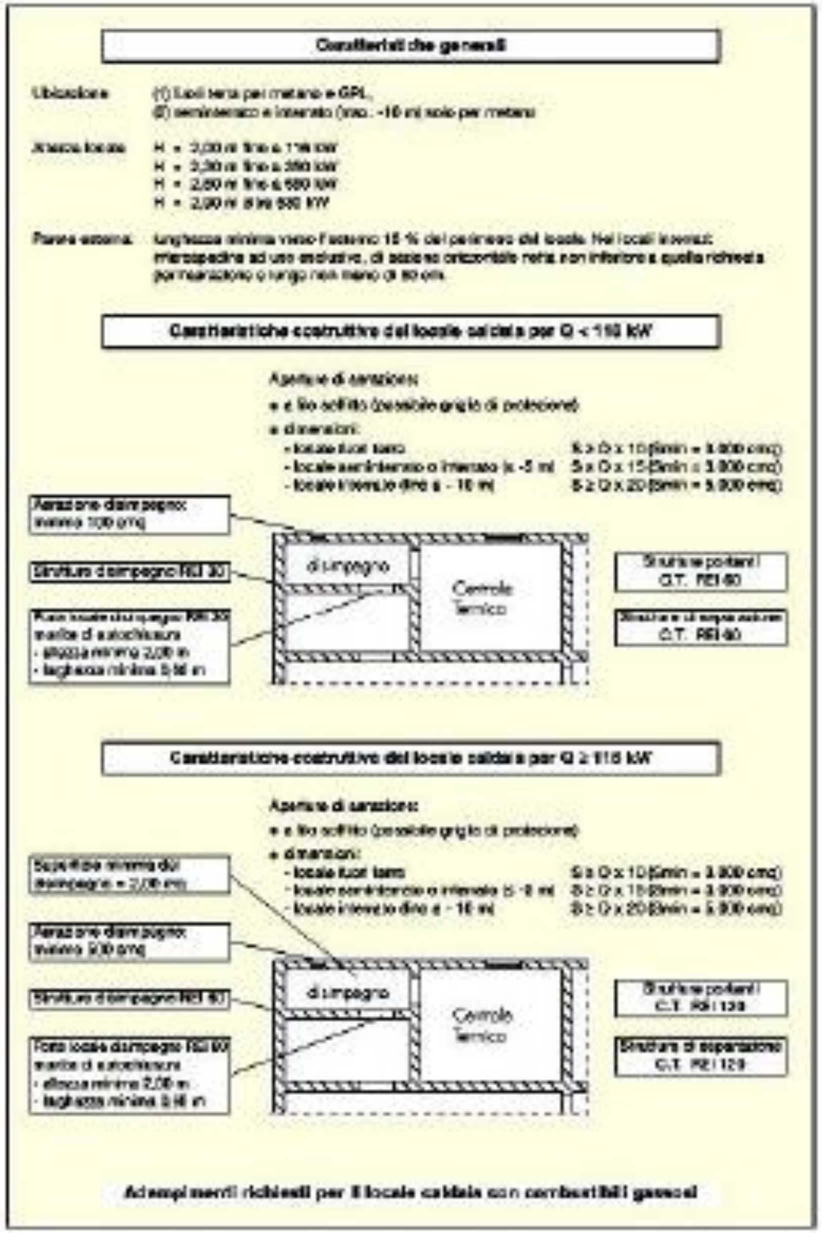
The formalities required for the local central heat with boiler fueled by liquid fuels are those who appear briefly in the figure, while the formalities required for the local boiler fueled with gaseous fuels are shown in the next figure



Formalities required for the central heat with liquid fuels

Thermal plants

Central heat



Caratteristiche generali

Ubicazione: (1) fuori terra per metano e GPL; (2) seminterrato e interrato (max. -10 m) solo per metano

Altezza locale:
H = 2,00 m fino a 116 kW
H = 2,30 m fino a 350 kW
H = 2,60 m fino a 580 kW
H = 2,90 m oltre 580 kW

Parete esterna: lunghezza minima verso l'esterno 15 % del perimetro del locale. Nei locali interrati: intercapedine ad uso esclusivo, di sezione orizzontale netta non inferiore a quella richiesta per aerazione o larga non meno di 60 cm.

Caratteristiche costruttive del locale caldaia per Q < 116 kW

Aperture di aerazione:
- a filo soffitto (possibile griglia di protezione)
- dimensioni:
  - locale fuori terra S ≥ Q x 10 (Smin = 3.000 cmq)
  - locale seminterrato o interrato fino a -5 m S ≥ Q x 15 (Smin = 3.000 cmq)
  - locale interrato oltre a - 10 m S ≥ Q x 20 (Smin = 5.000 cmq)

Caratteristiche costruttive del locale caldaia per Q ≥ 116 kW

Aperture di aerazione:
- a filo soffitto (possibile griglia di protezione)
- dimensioni:
  - locale fuori terra S ≥ Q x 10 (Smin = 3.000 cmq)
  - locale seminterrato o interrato fino a -5 m S ≥ Q x 15 (Smin = 3.000 cmq)
  - locale interrato oltre a - 10 m S ≥ Q x 20 (Smin = 5.000 cmq)

Adempimenti richiesti per il locale caldaia con combustibili gassosi

Thermal plants

<u>Central heat</u>

The chimney and the smoke canal, which links together the boiler and the flue, must be carried out as required by Legislative Decree no. 152/2006, whose main requirements are:

- <u>on the smoke channel</u>:
  a) measuring the combustion indexes (combustion efficiency, the concentration of carbon monoxide with buckets and airless fumes not exceeding 1000 ppm and, only for liquid fuels, soot count of not more than 2 of the Bacharach scale for diesel generators and 6 for those with fuel oil;
  b) two hole of levy of smoke;
  c) a door inspection;
  d) a hole to insert a thermometer for measuring the temperature of the fumes;

Central heat

La canna fumaria e il canale da fumo, che collega fra loro la caldaia e la canna fumaria, deve essere realizzato secondo quanto richiesto dal D. Lgs. 152/2006, le cui prescrizioni principali sono:

- on the fireplace:
  - a) a door of double wall inspection at the bottom and below the line that connects the smoke canal to the chimney itself;
  - b) two holesof lavy in the flue gas samples just above the line that connects the smoke canal to the chimney itself;
  - c) two holes of lavy of samples of fumes immediately below the outlet mouth of the chimney.

Thermal plants

Central heat

For their implementation and for the proper functioning of the boilers should be considered:

a) the regulatory issues

They concern the safety distances between the boiler and taxes walls by D.M. 12.04.1996 and D.M. 161/2005.

These distances depend on the type of fuel used:

- for liquid fuel boilers with a nominal heat output and at least 35 kW are subject to the requirements of D.M. 161/2005;

Central heat

For their implementation and for the proper functioning of the boilers should be considered:

a) the regulatory issues

These distances depend on the type of fuel used:

- for gas boilers with more than 35 kW thermal power, apply the requirements of D.M. 12.04.96, according to which the distances between the boiler and the walls of the room must allow a good accessibility to the adjustment components, and safety of the local control, and allow easy routine maintenance, leaving free spaces both on the water side of the boiler (in correspondence of the forward and return connections), which serve to remove "sludge" and deposits that depend on the level of oxidation of the plant and the "hardness" of the water used, both on the gas side, which serve for cleaning soot, which greatly increases when combustion is not smooth or when using inferior fuels;

Central heat

For their implementation and for the proper functioning of the boilers should be considered:

a) the regulatory issues

They relate to the need to protect the boilers with arrangements which prevent condensation of fumes.

This serves to:

- does not compromise the performance of combustion;
- prevent a rapid decay of boilers due to the fact that the flue gas condensate is very acidic, and can easily attack the boiler body, until it is unusable. The only boilers immune from such hazards are those at condensing, which are built to cope with this phenomenon, even with systems at low temperature it tends to exploit it. The boilers normal instead should be protected with devices able to prevent the water returns in the boiler under 55-60°C, because it is with values below a temperature that condense the flue gas in the boiler.

Central heat

For their implementation and for the proper functioning of the boilers should be considered:

b) the management issues

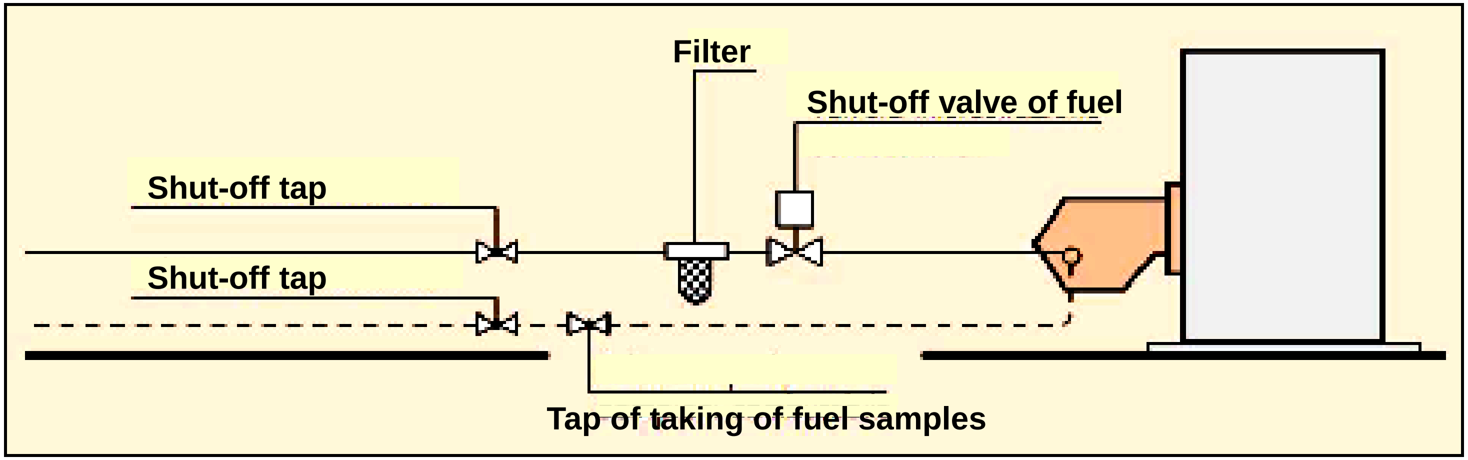
In this case you use two devices:

- use of anti-condensation pump: this increases the return temperature by entering it in water directly taken from gone. Its flow rate can be calculated by multiplying the power of the boiler by a factor equal to 0.03, while for the prevalence is good to adopt low values (0.1-0.2 bar) in that the pump only has to overcome the resistance of the boiler shell;
- use of a control valve and a priority sensor: it is a normal modulating control with limit probe on the return. On the probe sets the minimum desired temperature (e.g. 70°C) and the regulation acts by enforcing this limit. It is an anti-condensation device used in systems whose terminals working in average high temperatures (for example, fan heaters, fan convectors or finned coils) to avoid too cold returns in full operation phases.

Central heat

For their implementation must be respected :

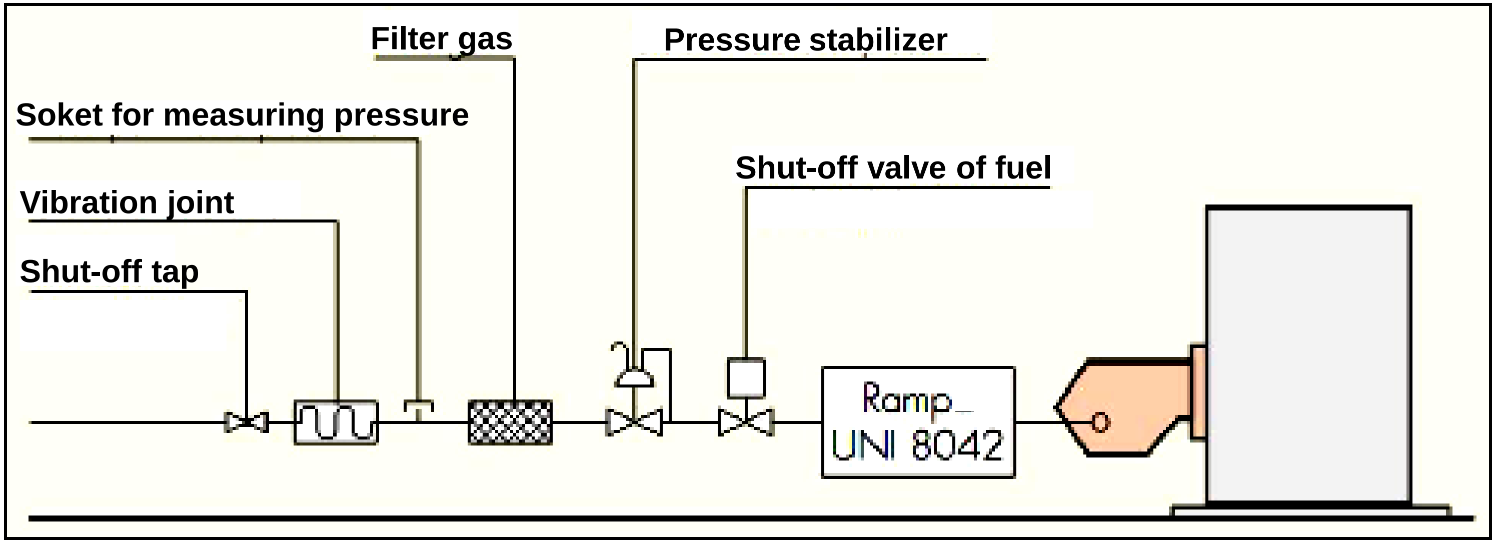
a) for liquid fuel burners the requirements of the Ministerial Decree must be respected 161/2005, whose devices for the feeding of oil burners with underground or elevated tank are visible in Figure



Central heat

For their implementation must be respected:

b) for gaseous fuel burner (methane) the requirements of the standard must be complied with UNI EN 676: 2008, where the devices for feeding the gas burners are visible in the figure



Central heat

For the handling of the heat transfer fluid are installed of electric pumps, that can be installed with both horizontal and vertical axis. They put in work medium-large pumps with elastic joints to avoid that the vibrations and the noises, generated by the same, are transmitted to the system.
The pumps agrees to install them in accordance with the plant to expansion vessel at closed configuration, both the outward and the return, even if in this second case are exposed to the danger of blockages caused by the corpuscles that are formed to the onset of corrosive phenomena along the tubes of 'plant. This danger is smaller for the pumps installed on the discharge, given that the filters, hydraulic separators etc. they retain these corpuscles.

<u>Central heat</u>

The volume of the expansion tank closed membrane V_e can be obtained from the following relationship:

$$V_e = \frac{C \cdot (e_2 - e_1)}{1 - \frac{p_i}{p_f}} \qquad (\mathrm{dm}^3)$$

where:

C = capacity or total content of water in the plant (dm^3);

e_2 = coefficient of expansion water to the final temperature or maximum of operating(°C).

e_1 = coefficient of expansion water to the initial temperature or minimum of operating (°C);

p_i = absolute pressure of charge of the vessel, which has to overcome the static pressure at the point where it is installed the expansion tank of at least 0.15 bar (are advisable increments of 0.3-0.4 bar);

Central heat

I valori dei coefficienti di espansione dell'acqua rispetto alla temperatura di 4°C sono riportati in tabella

Temperature (°C)	Coefficient of expansion (-)	Temperature (°C)	Coefficient of expansion (-)
5	0,0000	10	0,0003
15	0,0009	20	0,0018
25	0,0030	30	0,0043
35	0,0058	40	0,0078
45	0,0098	50	0,0121
55	0,0145	60	0,0170
65	0,0198	70	0,0227
75	0,0258	80	0,0290
85	0,0324	90	0,0359
95	0,0396	100	0,0434

Central heat

The volume of the expansion tank closed membrane V_e can be obtained from the following relationship:

$$V_e = \frac{C \cdot (e_2 - e_1)}{1 - \frac{p_i}{p_f}} \qquad (\mathrm{dm}^3)$$

where:

p_f = absolute maximum pressure refers to the vessel pressure (bar). This value may be determined using the relationship:

$$p_f = p_{vs} + p_{\Delta H}$$

where:

p_{vs} = absolute pressure of the safety valve calibration (bar);

$p_{\Delta H}$= pressure corresponding to the altitude difference between the expansion vessel and the safety valve (bar). If the expansion vessel is lower than the valve, its value is negative, while if higher is positive.

Central heat

To determine the expansion tank closed membrane required from the heating plant under consideration must be known the following characteristics:

$C = 800\ dm^3$;

$e_2 = 0{,}0290$ at temperature of 80°C;

$e_1 = 0{,}0009$ at temperature of 15°C;

$p_i = 1{,}5$ bar;

$p_f = 3{,}5$ bar;

$p_{vs} = 0{,}1$ bar;

$p_{\Delta H} = 1$ bar;

for which it is

$p_{i\ effettiva} = (1{,}5 + 1) = 2{,}5$ bar;

$p_{f\ effettiva} = (3{,}5 + 0{,}1 + 1) = 4{,}6$ bar.

<u>Central heat</u>

The volume of theclosed expansion vessel to membrane V_e is:

$$V_e = \frac{C \cdot (e_2 - e_1)}{1 - \frac{p_i}{p_f}} = \frac{800 \cdot (0{,}0290 - 0{,}0009)}{1 - \frac{2{,}5}{4{,}6}} = 49{,}3 \ dm^3$$

which approximates to 50 dm^3, standardized size present on the market.

In order to verify the operation of the pumps it is advisable to assemble, in by-pass of the pumps, a pressure gauge with two shut-off valves.

Thermal plants

Central heat

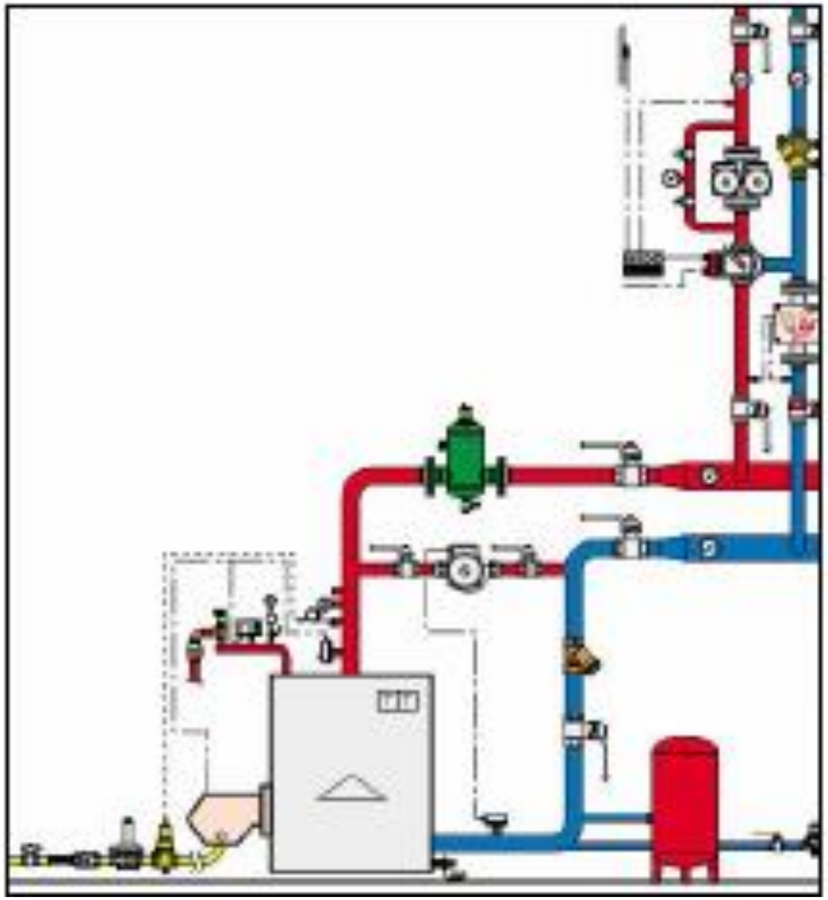
It is advisable to install thermometers in the go and return on the various circuits. It is thus possible know the average temperatures that are operating the terminals.

It must be carefully planned and put into operation of the shut-off valves so as to make trappable all the most important components. Similarly the envisaged use of the check valves, which must be ordered in work to prevent possible improper circulations of the fluid.

They are also envisaged that the collectors have the purpose of distributing and collecting the fluid more circuits.

Central heat

The figure shows a schematic diagram of the various components present in the central heat



Thermal plants

Liquid fuel tanks

The storage of fuels must be such that:

- the storage site should be placed at least 10 m from the other buildings;
- the metal tanks must be equipped with earthing;
- the metal tanks must be equipped with vent conducted at least 2 m above the ground.

Liquid fuel tanks

The deposit of fuel oil or diesel oil, consisting of one or more reservoirs, can be located outside or inside the building in which the heating plant is installed.

If located outside storage, the fuel tanks can be basement in the courtyard, street or installed in sight in a special and distinct local or outdoors. In the case of storage located within the tanks they can be basement under the floor or installed in rooms having a view of at least one wall of stating an open ceiling spaces (streets, courtyards, cavities).

Thermal plants

Liquid fuel tanks

The capacity of each tank to Diesel fuel can not be greater than 15 m3. Depending on the location of the store you can be installed one or more tanks, provided that the following limitations are observed:

a) no more than 2 tanks, if installed in plain view in the building;

b) no more than 3 tanks, whether basement inside the building;

c) no more than 6 cylinders, if the outside of the building sites.

Liquid fuel tanks

The tanks must have the following characteristics:

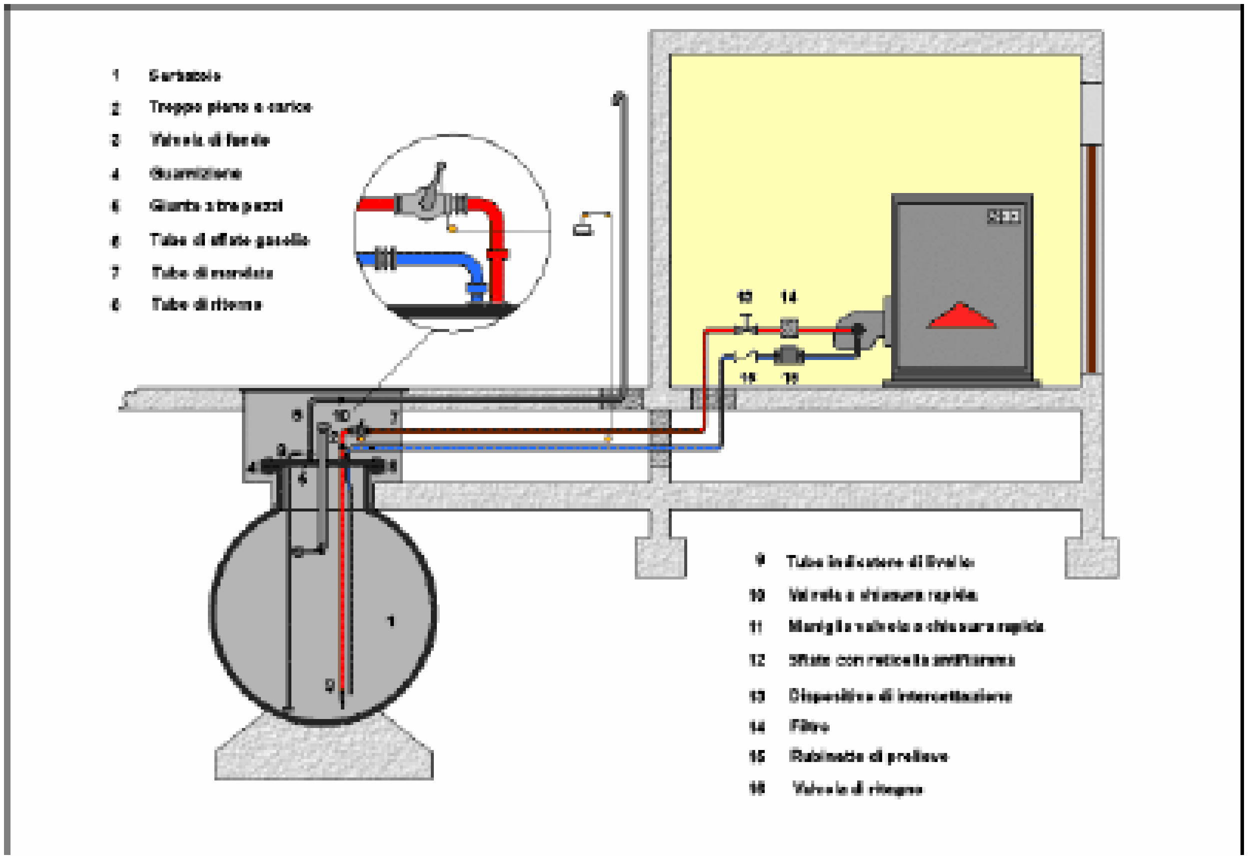
a) deposit at outside with fuel oil tanks basement

The top generating tank must be not less than 0.20 m below ground level; in the case where it is expected the transit of vehicles, the generator must be not less than 0.70 m. The minimum distance between the tank and the outer wall of the building must not be less than 0.50 m

Liquid fuel tanks

The tanks must have the following characteristics:

a) deposit at outside with fuel oil tanks basement



Liquid fuel tanks

The tanks must have the following characteristics:

b) deposit outside with diesel tank in sight

Tanks must be installed in a special room at no less than 0.50 m from the floor, on special masonry saddles. The walls and floors of the room must have the same requirements for the boiler room. The access door must have, in any case, the elevated internal threshold, the local waves can constitute a containment basin, having a volume equal to the capacity of the tanks. Between the tanks and between them and the walls of the room must be a minimum distance of at least 0.60 m. there must be no communication between the local deposit with other environments

Liquid fuel tanks

The tanks must have the following characteristics:

b) deposit outside with diesel tank in sight

Liquid fuel tanks

The tanks must have the following characteristics:

c) deposit outside with diesel tank in outdoor view

The tanks must be equipped with grounding and containment basin with capacity equal to a quarter of the volume of the tank, which can be realized in masonry, reinforced concrete, embankment on earth etc.

Other essential features are:

- the liquid fuel depots should be placed on rigidly anchored supports;
- whether next to transit routes, they must be protected from the curb of more than 0.20 m high;
- the liquid fuel depots should be distant from the heat generator more than 5 m;
- if the walls of the room are combustible, the distance from the generator must be greater than 0.60 m;

<u>Liquid fuel tanks</u>

The tanks must have the following characteristics:

c) deposit outside with diesel tank in outdoor view

The tanks must be equipped with grounding and containment basin with capacity equal to a quarter of the volume of the tank, which can be realized in masonry, reinforced concrete, embankment on earth etc.

Other essential features are:

- if the ceiling of the room is combustible, the distance from the generator must be greater than 1 m;
- as an alternative to the above two conditions, there must be a protection REI 120;
- there must be an impermeable containment basin increased capacity of 25% of the tank;
- pumps for refueling must be suitable (IP55 protection on the electrical panel; location not adjacent to the building openings);

Liquid fuel tanks

The tanks must have the following characteristics:

d) deposit inside with fuel oil tanks basement

Between the tanks and the walls of the room must pass the distance of at least 0.60 m. The walls and floors must submit the same requirements for the boiler room

Liquid fuel tanks

The tanks must have the following characteristics:

e) deposit inside with diesel tank in sight

I serbatoi devono essere installati a non meno di 0,50 m dal pavimento su apposite selle in muratura; le pareti ed i solai devono presentare gli stessi requisiti prescritti per il locale caldaia; la porta di accesso deve avere, in ogni caso, la soglia interna sopraelevata onde il locale possa costituire bacino di contenimento di volume uguale alla capacità dei serbatoi; tra i serbatoi e tra questi e le pareti del locale deve esistere una distanza libera di almeno 0,60 m; tra il punto più alto del serbatoio ed il solaio di copertura, deve sussistere una distanza non inferiore a 1 m.

Liquid fuel tanks

Access to the local store, located in a special room outside with tanks in sight, must take place solely and directly from an open ceiling space.
Access to the storage rooms, located inside with underground tanks, or in sight, must have the same requirements for the boiler room. The storage rooms may be in communication with each other only by means of de-commitments. It is not permitted that the room for the storage has direct communication with local openings for another purpose.
In municipalities where the requirements of the Regulation do not apply to the Legislative Decree no. 152/2006, the storage room must have one or more of direct openings to the open sky space whose surface is less than 1/30 of the local plan area itself.

Liquid fuel tanks

Access to the local reservoirs must be fitted with ports that have the same characteristics as those of the access boiler rooms.

The diesel tanks and fuel oil should be constructed of materials approved by the Interior Ministry, the approval of which are also subject the shape and construction of the personal tanks, pursuant to art. 2 of the law 27 March 1969 n. 121. They must be hermetically sealed so as to be watertight under a test pressure of not less than 1 bar. The favorable outcome of that test must be documented by the manufacturer of the tank.

<u>Liquid fuel tanks</u>

The fuel tanks must have appropriate protection against corrosion and must be equipped with:

a) tube metal of loading firmly fixed to the tank and having the free end placed in manhole basement or in a niche in the wall of the building, but located so as to avoid that the fuel, in the event of spillage, the underlying premises invade;
b) vent tube of vapor having an internal diameter equal to half the diameter of the inlet hose and in any case not less than 25 mm and leads outside the building at a height not less than 2.50 m from the outer practicable floor and away from windows and doors; the end of the pipe must be protected with gauze flame trap;
c) device suitable for interrupting, during loading, the flow of the fuel when it reaches 90% of the geometric capacity of the tank; this must be approved by the Interior Ministry as a result of tests carried out at the study center and experiences fire fighting.

Thermal plants

Liquid fuel tanks

As regards the Thermal plants fueled by methane gas, the part of the plant between the point of delivery of the gas (the gas delivery cabin with pressure reduction of the second jump - figure) and the equipment, outdoor and outside the central (for example of the general shut-off valve, the automatic locking valve etc.) is not to be considered as danger of explosion if presents emission sources with failure hole not exceeding 0.25 mm^2

Liquid fuel tanks

The most common delivery pressure for thermal plants small-medium, without a downstream reduction system, is 20 mbar. In some cases the pressure may be 40 mbar, while in the case of higher pressures is a must to classification with the general rule.

In the present case, the delivery point is placed within a box located on the outside, near the gate. It is a closed environment with the volume of about 2 m^3 and an opening is present on the lateral wall high degree of ventilation with low and adequate availability. Indeed valves, various connections, measuring instruments that can emit continuously very small quantities of gas and according to CEI 31-30 may be disregarded are installed in the plant

Liquid fuel tanks

It is provided the periodic monitoring the state of the environment with preventive maintenance tasks (leakage control, the protections of the pipes from corrosive actions etc.).

The methane gas is then transported from the point of delivery to the central heat through a pipe that has the threaded couplings and shutoff valves.

Apparecchi per il riscaldamento dell'ambiente industriale

The rational use of a heating plant combined for heating of the workplace should lead to a minimum cost of management ensuring maximum environmental comfort. For the numerous heating In industrial environments, they respons:

a) heaters

They are of the equipment in pre-painted sheet steel, complete with adjustable aluminum louvers placed on the air delivery.

The battery exchange can be made of copper pipes and aluminum fins with high thermal conductivity to optimize the exchange than batteries with traditional iron pipe.

To realize the air jet sub-horizontal or vertical down using an axial fan driven by a three phase electric motor at double speed.

They are generally installed at 3-4 m in height from the floor.

Thermal plants

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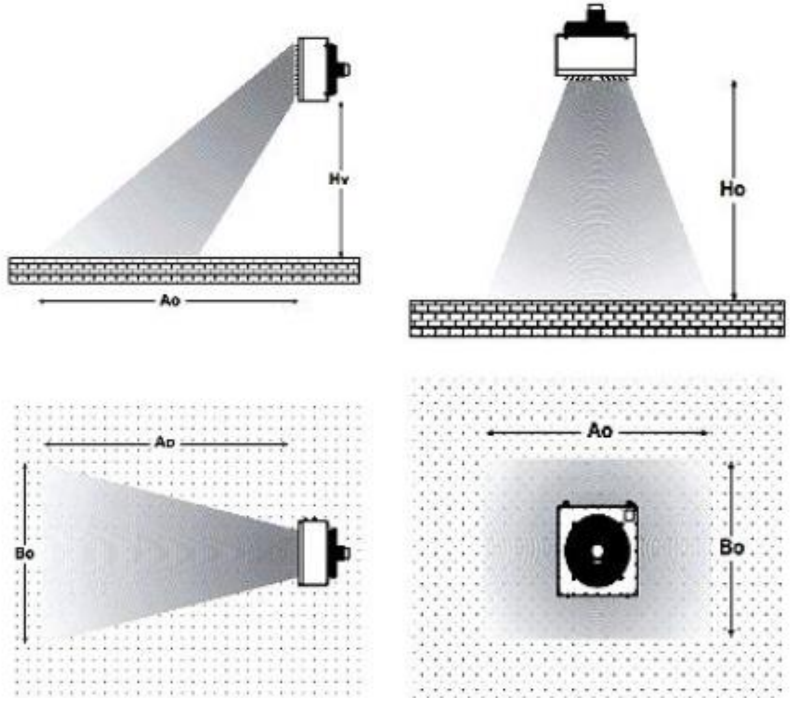
The figure shows the quantities characterizing the installation of the heaters mounted on walls and ceilings and which are characterized, for the first device, in maximum height installation H_v, lancio A_o and floor area of influence B_o, and, for the second unit, maximum installation height and zone of influence to foor A_o and B_o.



Apparecchi per il riscaldamento dell’ambiente industriale

The rational use of a heating plant combined for heating of the workplace should lead to a minimum cost of management ensuring maximum environmental comfort. For the numerous heating In industrial environments, they respons:

b) sun-strip panels or radiant free expansion

They consist of sheet metal strips, insulated on the upper side, heated by means of tubes parallel between them and placed in contact with the sheet itself. Inside the tubes circulates the heat transfer fluid (superheated water, steam). The heat is transferred by radiation and are installed in the upper part of the building. They are used in rooms where you want to avoid air movements (for example, bathrooms and showers) and dust lifting (manual painting systems);

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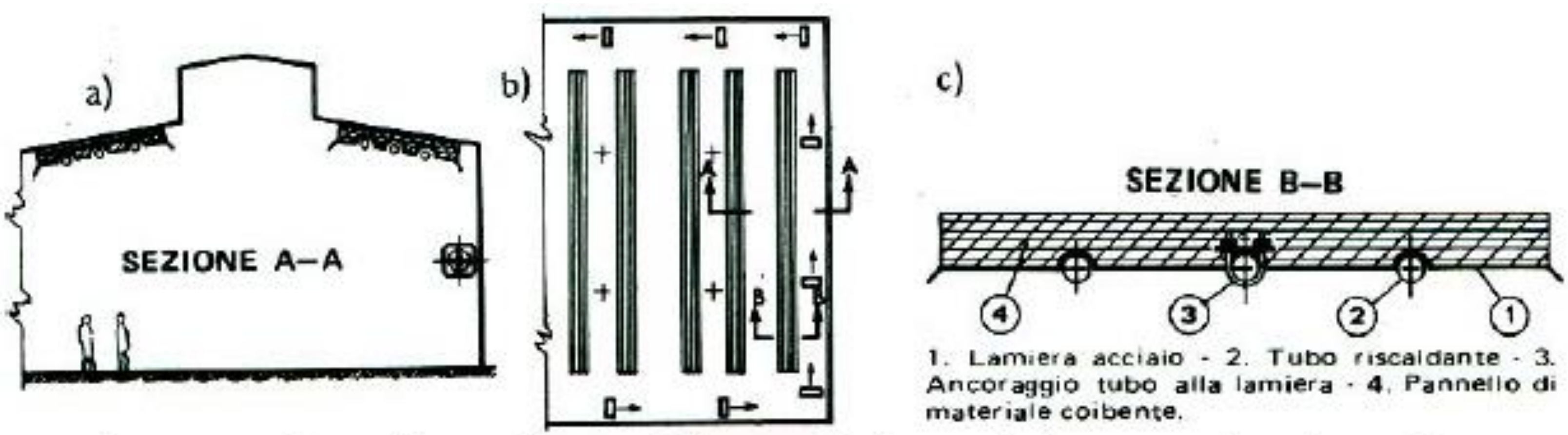

Apparecchi per il riscaldamento dell’ambiente industriale

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c) fan heaters

They consist of a heating battery and a fan mounted in a metal housing having mouths with dampers for the suction and the supply of air ventilation, which allow users to enter the warm air in the environment to be heated.

The fan heaters are powered by hot water, superheated water or steam and exchanges heat within a finned heat exchanger

Apparecchi per il riscaldamento dell'ambiente industriale

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d) hot air generators

They heat up the air by heat exchange with the combustion gases of a gas or a liquid fuel. Each generator has therefore a burner with a built-in fan for the circulation of the combustion gases. It is constituted by a metal outer casing (figure), inside which has a combustion chamber made of sheet steel which is lapped from the outside from the air, a tube bundle path internally by the fumes from the air outside and lapped, of the air inlet and the air outlet, and an air circulation fan.

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e) direct heaters

Are similar to a hot air generator in which heat is produced by the same and the combustion gases, a gaseous sulfur-free fuel (LPG or methane), are mixed with the hot air and released into the environment to be heated (figure)