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INGENIERÍA Y MATERIALES TÉCNICOS INDUSTRIALES, S.A.

VACUUM EQUIPMENT • EJECTORS

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EJECTOR: WORKING PRINCIPLE

An ejector is a vacuum pump, generally driven by steam, without moving parts. It is the simplest of the pumps, although it can produce absolute pressures from one micron to 30 inches of mercury column.

The working principle of an ejector is the following: the motive fluid, generally steam, is accelerated inside a convergent-divergent nozzle, which converts pressure into velocity.

Because of the Venturi effect, the resulting discharge pressure is very low, which as a result creates a suction of the suctioned fluid into the mixing chamber.

The mixture of motive and suctioned fluids then passes into the diffuser, which transforms the velocity into pressure, and we get at discharge a pressure between the motive and suctioned fluid.

Basic components: (Figure 1)

- Chamber of aspiration
- Nozzle
- mixing diffuser

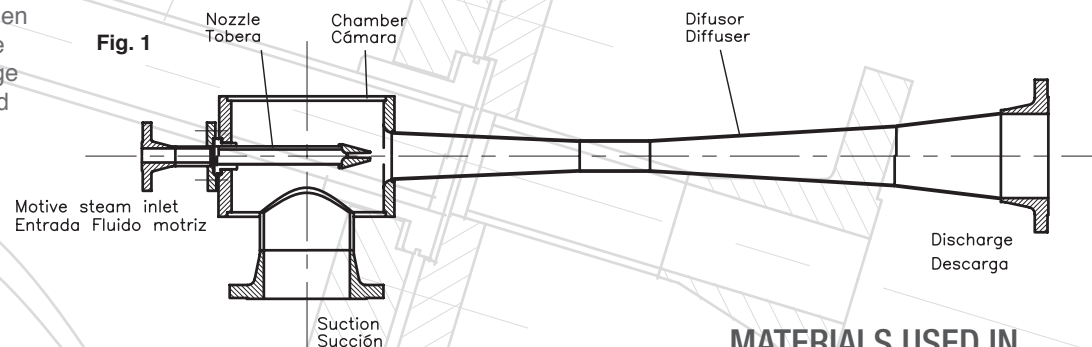
SELECTION FACTORS

While the ejector assembly in itself is simple, the design of the nozzle and diffuser are quite sophisticated. The factors to be considered are:

1. Pressure and temperature at ejector suction flange.
2. Discharge pressure required.
3. Nature of the load (composition, corrosive vapours).
4. Required capacity of the ejector.
5. Minimum steam pressure for the ejector system.
6. Maximum temperature of water entering the condenser.
7. Type of condenser required: barometric or surface.

MAIN INDUSTRY APPLICATIONS FOR EJECTORS

- **Chemical:** Distillation, concentration, evaporation and drying.
- **Petroleum:** Crude oil distillation, atmospheric distillation.
- **Steel:** : Degassing, removing of hydrogen and gaseous impurities.
- **Pharmaceutical:** Protective drying at low temp. of blood and antibiotics.
- **Food:** evaporation, concentration, drying.
- **Electrical:** Cable drying impregnation.
- **Textile:** Manufacturing of synthetic fibres and fabric drying.
- **Sugar:** Evaporation and juices concentration
- **Vegetable oil:** Deodorising and edible oil drying.
- **Plastics:** Drawn, extrusion, injection, forming.
- **Mechanic:** Tank drains.
- **Paper:** Rotative filters of low vacuum.
- **Aerospace:** Vacuum Test chambers, turbomachinery testing,



MATERIALS USED IN EJECTOR AND VACUUM SYSTEMS

Depending of several factors, namely: mechanical properties, chemical resistance, economics and purity of product.

Materials can be:

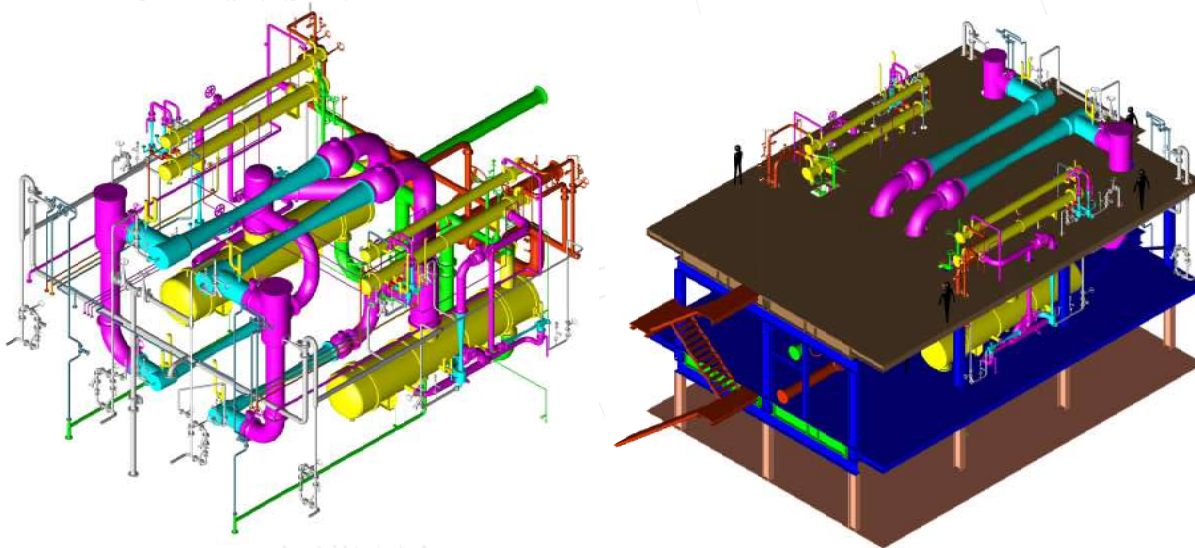
- Carbon steel
- Stainless steel (304L, 16, 321)
- 90 or 3P stainless
- Copper
- Nickel
- Monel
- Titanium
- P.V.C.
- Resin
- Nylon
- Polypropylene
- Glass
- Ceramic
- P.T.F.E.
- Polyethylene
- Graphite

MULTISTAGE VACUUM PACKAGES

The amount of steam required to operate an ejector increases proportionally to the required compression ratio. This fact limits the single stage ejectors.

The most efficient operation method is to use several stages of ejectors with intermediate condensers to condensate (to remove) the steam used in the previous stage.

This way, only non condensables move to the next stage and the steam flow required is reduced considerably.



HYBRID VACUUM PACKAGES

One or two ejectors in series with a liquid ring pump :

- A. The gas to be suctioned is compressed in an ejector.
- B. Motive steam is condensed in an appropriate surface condenser.
- C. Gas at condenser outlet is suctioned by a liquid ring pump and discharged to the atmosphere.

This package offers a reduction in the steam consumption, easy erection and small dimensions.

SURFACE CONDENSERS

In these condensers they are separated, usually by tubes. These are used in processes where the fluids cannot be mixed. Applicable codes: TEMA; ASME...

Proper ejector staging is determined by the suction pressure to be maintained, the magnitude and nature of the load and the evaluation of the initial and operating costs by the customer.

Wide experience in designing and supplying complete vacuum packages in modular skids for transportation and easy assembly at the Plant.



GUIDANCE FOR SELECTION TABLE

Suction pressure (*)	Number of stages required ejectors
Simple 100 mbar and higher	Single stage
15 mbar to 100 mbar	Two Stages
1 mbar to 15 mbar	Three Stages
0.3 mbar to 1 mbar	Four Stages
Mbar to 0.3 mbar 0.05	Five Stages
0.8.10 -3 mbar to 0.05 mbar	Six Stages
Less than 10-3 mbar	Seven Stages
(*) : For atmospheric discharge	

STEAM TURBINE CONDENSERS

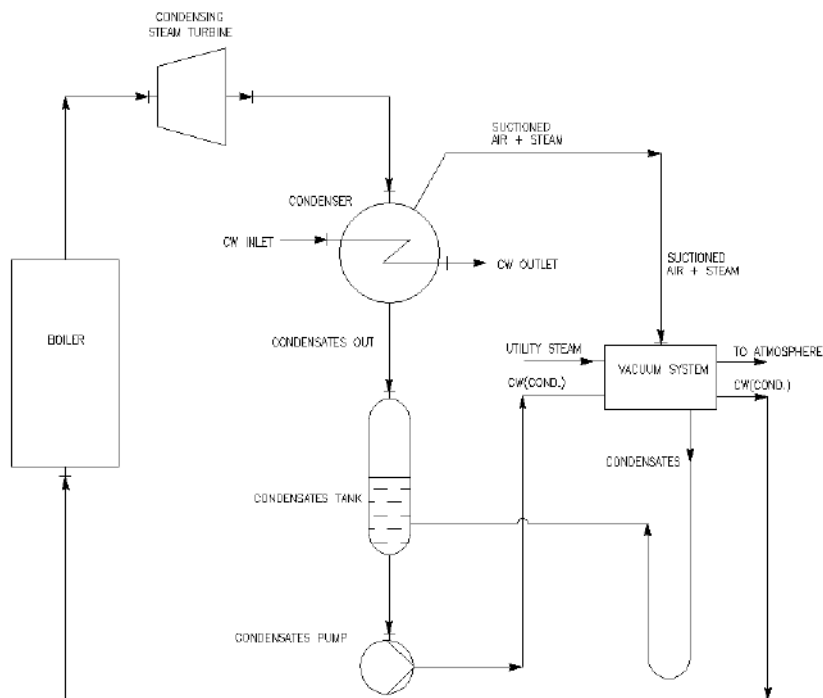
To increase energy efficiency in steam turbines, reducing the discharge pressure below atmospheric with a vacuum package called **Air removal package**.

Condensates from main condenser are used as cooling water for the vacuum system.

Gland ejector to suck air inside seals (prevents steam leakages).

Discharge pressure at ST depends on CW temp. for main condenser, because it is the steam saturation pressure at that temp.

We can supply the complete condenser or just the **Air Removal Package**.



STEAM DESUPERHEATERS

PURPOSE: to inject water in a steam flow to reduce its temperature.

Widely used in steam installations to adjust steam balances.

Regulation: with a control valve in the water line, using the discharge Temperature signal.

Can be installed in any position. No need to install droplet separator.

If it is upstream a rotating equipment, install vertically.

Minimum Maintenance: only replacement of nozzle.