Jet ejectors for the oil industries

Vacuum solutions for refineries and the petrochemical industries

Körting HANNOVER AG

THE EJECTOR COMPANY

Vacuum distillation

From plant planning to commissioning

Vacuum distillation is used in oil refineries if long-chain hydrocarbons require separation. By applying a vacuum column, the boiling point of the substances to be distilled is lowered, making separation of the hydrocarbons easier.

At the beginning, atmospheric distillation generates initial products from the oil (including petrol and kerosene). However, atmospheric or long residue is produced. This is distilled in another distillation tower under vacuum (typically at approx. 20 mbar). Due to the decreased pressure in the vacuum tower, the boiling point of the residue components is reduced and the heavy hydrocarbons evaporate without disintegrating, which would be the case at higher temperatures. Refineries operate this process to produce vacuum gas oil, various distillates for conversion plants, or lubricant production and vacuum residue for heating-oil- and bitumen-components.

Higher yield of light products

Due to the two distillation processes, there is a clear yield ratio between each of the products generated from a certain type of crude oil. As the need for light products confronts a declining demand for heavy products, refinery operators are trying to increase the yield of light products. This is where the products made from vacuum distillation come in. In conversion processes, they are processed and refined to become light, short-chain hydrocarbons. Products from vacuum distillation are primarily processed in catalytic cracking units and hydrocrackers. The vacuum residue is refined in thermal cracking and coker units and turned into low-molecular products.

Vacuum generation components

Vacuum generation plays a key role in refinery operations.

Reliable production is inconceivable without constant, fail-safe maintenance of the vacuum.

Which is why plant operators place stringent demands in terms of the reliability and performance of vacuum-generation components. Körting Hannover AG's vacuum technology meets these challenges in refineries and chemical plants all over the world.

Surface condenser used in an oil refinery

Jet ejectors

Ideal for vacuum generation

By harnessing motive flow as the energy source, jet ejectors create a pumping action. They don't require any mechanical drives or movable parts. Due to their simple design, they are ideal for substances that tend to soil very easily. Major suction flows to the tune of 2 to 3 million m^3/h at suction pressure of under 50 mbar (of the type commonly applied in oil refineries) can't be created so reliably with any other kind of vacuum pump. In order to achieve such low suction pressure, a multi-stage design is required. Several stages, each consisting of a jet ejector with after-condensers, are applied. The condensable parts of the mixed flow in the upstream jet ejector are condensed and the next jet ejector stage only has to compress the non-condensable parts. As a result, in a 5-stage plant, suction pressure of 0.1 mbar is achievable.

Specifically designed for each application, Körting jet ejectors can also be operated with low motive steam pressure (e.g. from waste steam) and at very high compression ratios.

Due to the lack of complexity in designs, maintenance requirements are exceptionally low. In addition to superb reliability, they also offer superior availability, even if they have been out of operation for longer periods of time. As jet ejectors have no potential sources of ignition of their own, the EU explosion directive ATEX does not have to be applied.

Depending on process requirements, jet ejectors can be designed so that they are unheated, partially or even fully heated. A lot of processes in refineries and the petrochemical industry operate at high temperatures and require steam for heating and also for steam distillation. Therefore, refineries have enough of the motive steam required to operate jet ejectors.

Condensers

In the oil industry, surface condensers are used for condensing between each of the jet ejector stages. In this case, the cooling water and process medium are strictly segregated. This prevents soiling of the cooling water. Körting surface condensers can use the shell or tubes for condensing. They can be designed with fixed tube sheets, or removable tube bundles (floating head or U-tube design).

In exceptional cases, should direct contact of the process steam with the cooling water be permitted, the more flexible and more effective mixing condensers can also be used.

Choice of materials

Processing oil places high demands on the materials the relevant components are made of. The choice of material is governed by the purpose intended and the corrosiveness of the process media. Another huge benefit of jet ejector technology comes to the fore here: **virtually any materials can be used to manufacture jet ejectors.**

The materials chosen are geared to the requirements of the process and customer concerned.

Some of the materials available include:

- unalloyed steels (carbon steel), if necessary suitable for HIC service and wet H_2S service
- stainless steels (austenitic and ferritic steels)
- duplex material
- high alloy nickel steel
- titanium
- special materials (e.g. copper, nickel, Hastelloy)

Liquid ring vacuum pump

In hybrid systems, a liquid ring vacuum pump is used as the last stage in generating vacuums. In contrast to jet ejectors, liquid ring vacuum pumps draw on electricity to generate vacuums and are beneficial in terms of power consumption.

However, some disadvantages shouldn’t be neglected:
- they are more susceptible to soiling from process media
- the need for maintenance rises steeply
- more spare parts are required
- investment costs are much higher

Because of the soiling problem, there are limits to the use of mechanical vacuum pumps, particularly in refineries.

Liquid ring vacuum pumps are also an integral part of the range. Whatever type of vacuum pump is required, as a vacuum specialist Körting Hannover AG is the ideal specialist to contact. Due to decades of experience with vacuum generation in oil refineries, the petrochemical industry and other applications, Körting Hannover AG can deliver a wide range of solutions for each and every purpose.

Körting offers the lowest steam consumption

Energy costs play a major role when operating an oil refinery. Which is why choosing the right vacuum system is very important. Jet ejectors need motive steam to function and mechanical vacuum pumps need electricity. In energy networks, motive steam for jet ejectors is often available at an attractive price as low pressure steam. This is where using jet ejector technology in particular pays dividends. Nevertheless, it's still vital for operators to examine the total energy consumption of a vacuum system.

By constantly enhancing its own development department, Körting Hannover AG is a trailblazer on energy consumption issues. On several test rigs, Körting engineers improve the steam consumption of the jet ejectors. As a result, energy efficient vacuum systems can be designed and supplied to suit each application, in some cases with much lower steam consumption than many global competitors.

Orders won are proof of Körting's quality

The reasons for Körting's leadership in vacuum technology become particularly obvious when the total cost of ownership is compared. In addition to investment costs, this approach also identifies the costs of operating the plant (energy costs, repairs, maintenance) over several years. As a result, operators can see in terms of the total costs which investment is superior over a period of several years. As a result of these comparisons, many plant operators have opted for Körting Hannover AG's vacuum solutions.

Assembly of a surface condenser destined for an oil refinery at the Körting plant in Hanover, Germany

Körting vacuum systems offer:

- low steam consumption
- smart solutions for each application
- custom-made design
- plants that operate reliably
- first class manufacturing quality

A sample calculation of steam consumption

A comparison of figures
Vacuum system for an oil refinery

		Körting vacuum system	Other supplier's vacuum system
Design parameters			
Suction flow	m³/h	1 200 000	1 200 000
Suction pressure	mbar	20	20
Utilities			
Motive steam (boosters, ejectors)	kg/h	32 000	35 000
Total steam flow	**kg/h**	**32 000**	**35 000**
Cooling water	m³/h	2 650	3 100
Total cooling water flow	**m³/h**	**2 650**	**3 100**
Hours operated per year		**8 250**	**8 250**
Steam costs per year (20.00 €/t)	€	5 280 000	5 775 000
Cooling water costs per year (0.10 €/t)	€	2 186 250	2 557 500
Operating costs per year	**€**	**7 466 250**	**8 332 500**
Savings after 5 years	**€**	**4 331 250**	

Investing in a Körting vacuum system can cut operating costs significantly on a permanent basis.

Vacuum column in an oil refinery in Russia with two Körting steam jet vacuum ejectors and downstream surface condensers

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