Design features and operation of jet ejectors

Jet ejectors

The term "jet ejector" describes a device in which a pumping effect is achieved using a motive fluid. A jet ejector requires no mechanical drive and has no moving parts. This basic principle applies to every jet ejector in different models and ranges of application. The application determines the design of the flow section.

A steam jet ejector is illustrated below as example (steam serves as motive fluid to create vacuum). The function depends, above all, on the design of the motive nozzle (2) and of the diffuser (4 + 5). The motive fluid passes successively through these two components.
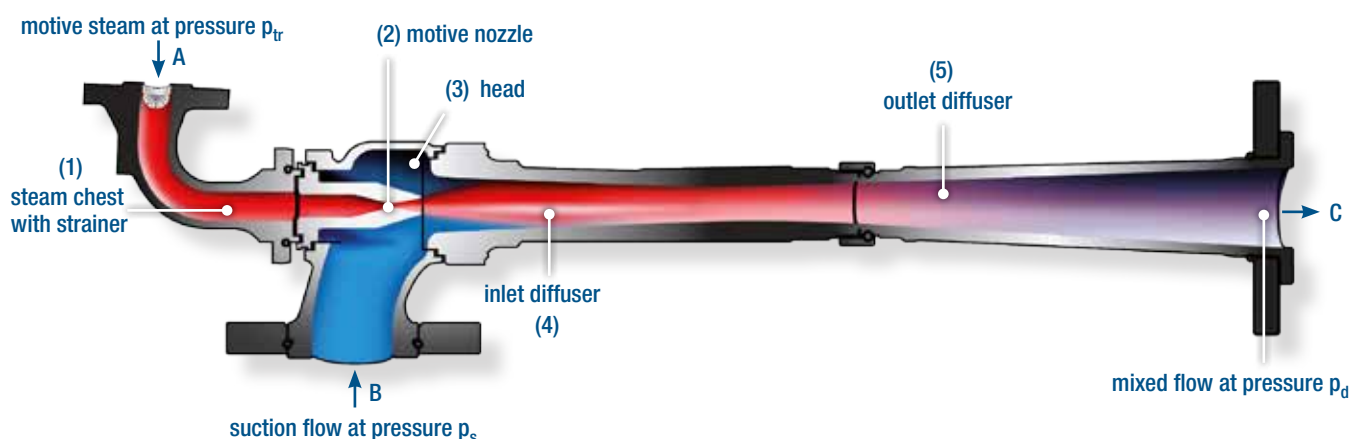
The flow section will change along this path. The pressure in the motive nozzle (2) decreases and the velocity rises. Conversely, the flow is decelerated in the diffuser (4 + 5) while its pressure increases to the discharge pressure at the outlet of the jet ejector.

The section between motive nozzle (2) and diffuser (4 + 5) has the lowest static pressure, approximately equivalent to the suction pressure p_s. At this point the suction flow enters into the ejector head (3) through the suction connection B and is mixed with the motive fluid flowing with high velocity. Part of the kinetic energy is transferred to the suction flow. Motive flow and suction flow pass together - as a mixture - through the diffuser, loosing velocity and gaining pressure. The increase from suction pressure p_s to discharge pressure p_d corresponds to the delivery head for the suction flow or to the pressure difference of the jet ejector. The ratio p_d / p_s is the compression ratio of a jet ejector.

In a jet ejector the static pressure energy of the motive flow which cannot be directly transferred is thus converted into kinetic energy. This kinetic energy can be released to the suction flow by impulse transfer while both flows mingle. The diffuser converts the kinetic energy of the mixture consisting of motive flow and suction flow back into static pressure energy.

In the steam jet vacuum ejector illustrated below, the critical pressure ratio is exceeded in the motive nozzle (2) (this can be recognized by the expansion of the nozzle cross-section downstream the minimum throat diameter.) The steam velocity exceeds the sonic velocity accordingly. Motive flow and suction flow are mixed at supersonic velocity and then decelerated to the sonic velocity upon reaching the diffuser throat. In the diverging section of the diffuser, the pressure finally increases to the discharge pressure p_d.

motive steam at pressure p_{tr}
A
(2) motive nozzle
(3) head
(5) outlet diffuser
(1) steam chest with strainer
C
inlet diffuser (4)
B
suction flow at pressure p_s
mixed flow at pressure p_d

Types and designations of jet ejectors

Jet ejectors are used to create vacuum, to compress gases, to convey liquids, to transport granular solids, to mix liquids or gases.

The motive fluid may be:
· steam at pressure above atmosphere
· atmospheric steam*)
· vacuum steam*)
· compressed gas or air
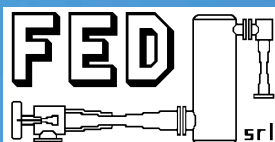· atmospheric air
· water or other available liquids

*) provided that the discharge pressure of the jet ejector or ejector stage in question is low enough.

The following table summarizes the terms of jet ejectors laid down according to DIN standards 24290. When defining certain types of jet ejectors, the standard terms for motive fluid and material delivered (gas, steam, liquid, solids) can be replaced by specific ones.

Example:
A liquid jet solids ejector using water as motive fluid to convey gravel can be designated as water jet gravel ejector.

suction medium contributing to designation	motive medium contributing to designation	gas jet ejector	steam jet ejector	liquid jet ejector
jet gas ejector	jet ventilator	gas jet ventilator	steam jet ventilator	liquid jet ventilator
	jet compressor	gas jet compressor	steam jet compressor (steam jet vapour compressor)	liquid jet compressor
	jet vacuum ejector	gas jet vacuum ejector	steam jet vacuum ejector	liquid jet vacuum ejector
jet liquid ejector		gas jet liquid ejector	steam jet liquid ejector	liquid jet liquid ejector
jet solids ejector		gas jet solids ejector	steam jet solids ejector	liquid jet solids ejector