

Throttling Valves Versus The RadMax Expander

Many processes of industrial importance require a flowing fluid to move from a region of higher pressure to one of lower pressure. Processes that accomplish this function are termed throttling processes, and the physical devices are generally called throttling valves. It is easy to suspect that such processes are wasteful. After all, whatever energy was used to increase the fluid's pressure is simply lost as the fluid expands into the lower pressure region. That is, in fact, correct. While of relatively simple design, throttling valves have no mechanism to recover the energy used to compress the fluid. And once the fluid is throttled to the lower pressure, that energy is no longer recoverable. It is, however, incorrect to say that the energy is lost. Rather, it is converted to a different form. Two thermodynamic principles are required to better understand these concepts.

First, all processes, regardless of their function, must abide by the First Law of Thermodynamics, and throttling processes are no exception. That is, processes can neither create nor destroy energy, although energy can change from one form to another. Second, a flowing fluid contains energy in several forms:

- **kinetic energy** - the energy of motion
- **potential energy** - the energy associated with altitude
- **flow work** - the energy associated with pressure, evaluated as pressure divided by density
- **internal energy** - the energy associated with molecular motion, plus that related to the bonds between molecules, between atoms, and between sub-atomic particles

During a typical throttling process, there are negligible changes in fluid velocity and height so that the kinetic and potential energies remain essentially unchanged. Thus, to comply with the First Law of Thermodynamics, changes in flow work, which are due to the reduction of both pressure and density, are accompanied by equal and opposite changes in internal energy; if one goes down, the other must go up by the same amount. Thus, the "lost energy" is actually energy converted from flow work to internal energy. But when a fluid is throttled, what is then indeed lost is the ability to recover the energy that was available in the pressure.

The alternative to throttling is to use an altogether different process whereby the fluid is allowed to expand through a rotary device such as the RadMax expander. The fluid flows through the expander driven by the pressure difference between the inlet and outlet pressures, and within it, the fluid expands as its pressure decreases. But here, the design is such that the forces caused by the pressure differences and the expansion of the fluid rotate the expander's shaft. Hence, rather than completely converting the flow work into internal energy as in a throttling valve, part of the flow work is converted to shaft work, that is, the energy associated with a turning shaft, and the balance to internal energy. The shaft work can then be used to drive a generator or some other device. Hence, the RadMax expander allows the recovery of a portion of the energy used to compress the fluid that is unrecoverable with a throttling valve. It should be noted that the actual amount that is convertible to shaft work is limited by the laws of thermodynamics and by the device's efficiency.