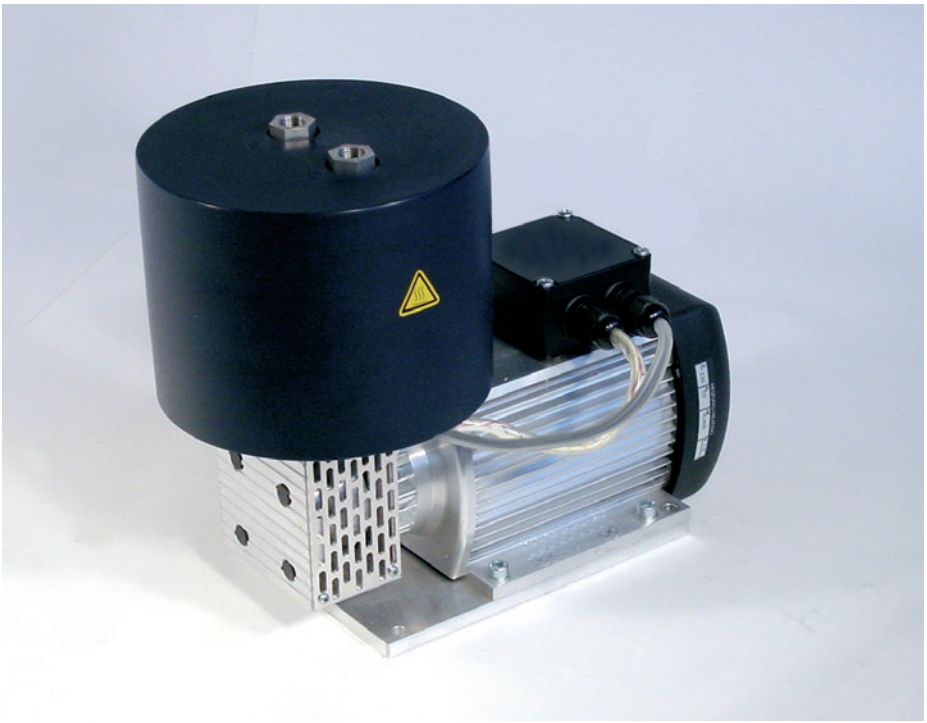
Turning on the Heat

Diaphragm pumps transfer media without adding contamination



Manfred Gut

Their oil-free operation makes diaphragm pumps ideal for a large range of applications in process engineering and analysis. When transferring hot gases, pump components that contact the media must be temperature resistant. Depending on the precise application, it may also be necessary to heat the pump head. A series of temperature resistant and heated diaphragm pumps fulfill all practical requirements, as two applications demonstrate below.

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Diaphragm-pump design principles contain two characteristics that are important for process engineering: The pumped medium is not subjected to contamination; and the pumps exhibit a high level of gas tightness. This is how a diaphragm pump works: The pump housing clamps an elastic diaphragm at its outer edges, which an eccentric then moves up and down. As it moves downward, the diaphragm draws the medium through the inlet valve, which works autonomously due to pressure conditions inside the pump. During its upward motion, the diaphragm pushes the medium through the pump's autonomously operating outlet valve and out of the pump. The diaphragm hermetically seals the pump chamber from the drive section, so besides being a pumping element it also acts as a seal.

Avoiding condensation

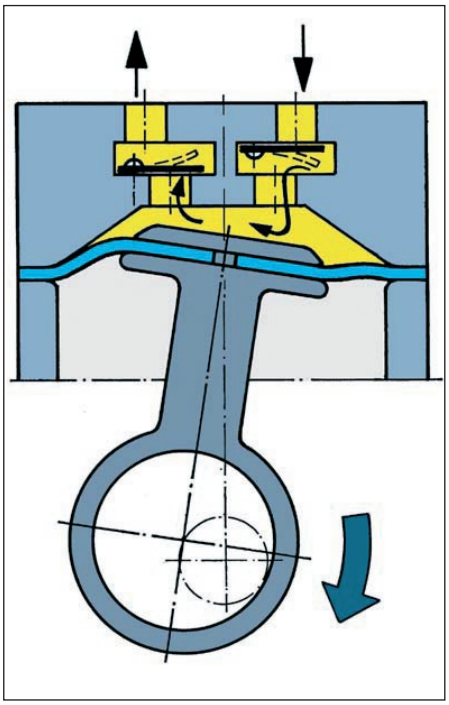
Process engineering and chemical analysis both depend on the ability to transfer hot gases and vapors. Diaphragm pumps with components able to withstand up to 240 °C are ready to handle these challenges. However, in many applications temperature resistance alone is not enough. In these cases, it is equally important for the medium temperature to remain constant during the pumping process. If the medium were to cool, individual components of the gas may condense out. Diaphragm pumps with heated pump heads are the solution to this problem.

More than 30 years ago, KNF Neuberger became the first manufacturer to develop and sell pumps with heated heads. Since that time, the technology has continued to advance. Today, the company offers its customers a spectrum of products with flow rates ranging from 6 to 100 liters per minute. In addition to temperature-resistant versions without head heating, KNF also offers heated versions with thermostatic temperature control and others with electronic temperature control. Pump components that contact the media are available in a variety of materials; a version employing a combination of stainless steel and PTFE is universally chemical resistant and suitable for aggressive media.

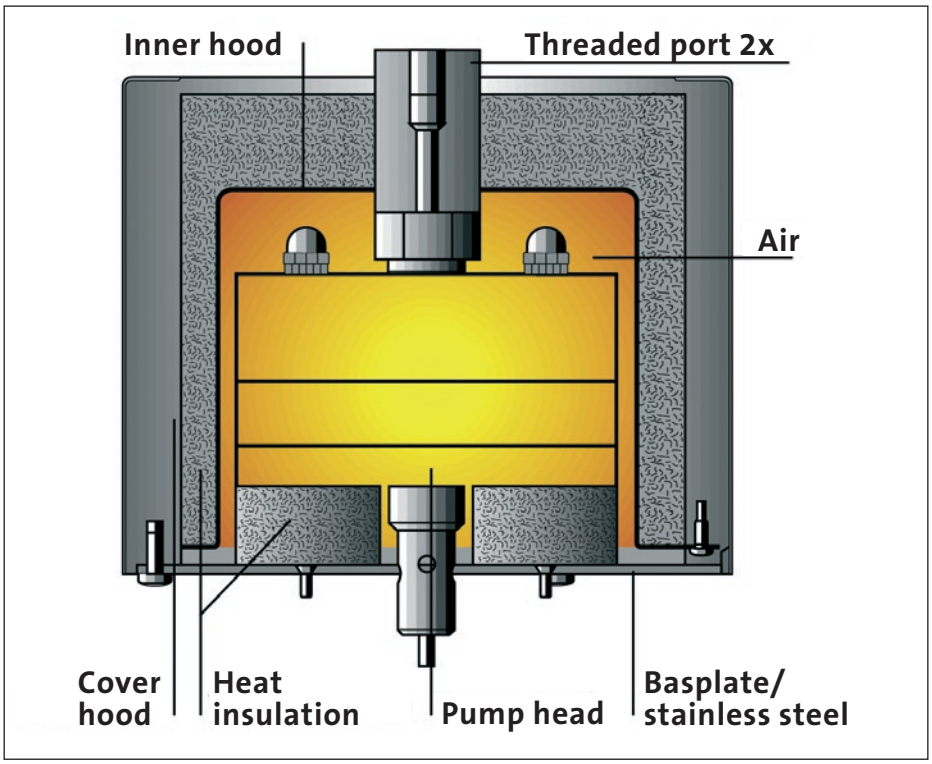
gas analysis system

Gas analysis systems are used to monitor processes and inspect exhaust gases in industrial facilities, steel mills, and power plants.

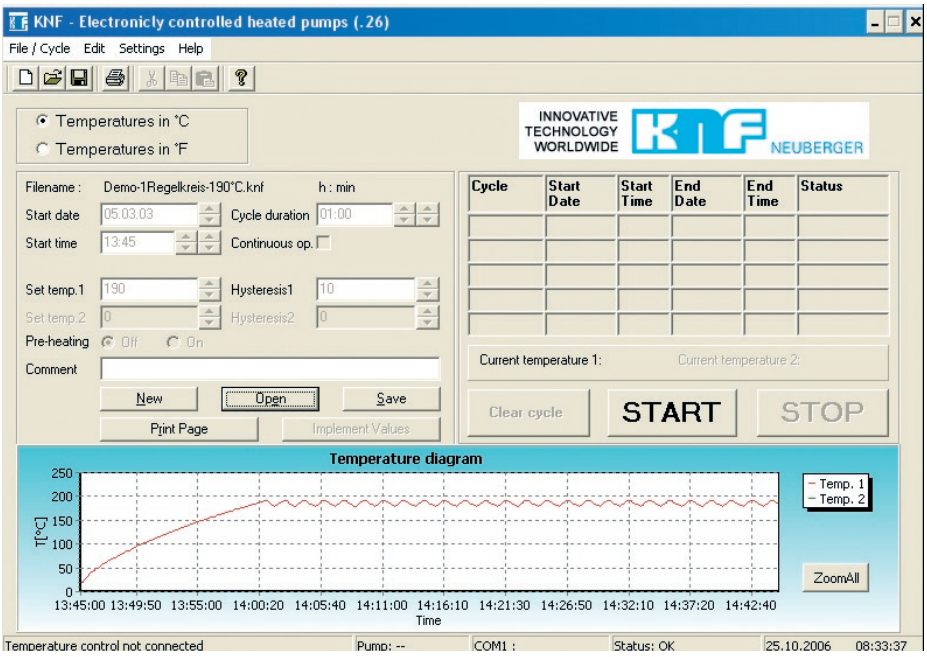
Infrared photometers are a common means of analyzing gas. Depending on the type of plant, suction lines of up to 100 meters in length may be necessary for bringing measurement gas to the instruments. Any



Diaphragm pump schematic



Pump heat insulation



PC software interface for entering values and documentating heating cycles

component through which measurement gas flows must be heated in order to prevent gas components from condensing out of the gas and to prevent corrosion.

For the same reasons, a diaphragm pump that pushes measurement gas through analysis instruments must also be heated. Pump type N 036.11 is the ideal choice in these situations. This unit has a heated pump head with thermostatic temperature control. The pump heads are made of stainless steel, while the diaphragm and valves consist of a modified PTFE compound.

Two important requirements for the pump are 1) homogenous temperature distribution throughout the entire pump head in order to avoid cold spots and condensation and 2) minimal heat emissions into the ambient air to avoid significantly elevated temperature in the analysis cabinet. For this purpose, patented insulation fully encapsulates the pump head in the form of a removable cover. The insulation has four layers: Air provides insulation directly at the pump head. This enables contact-free assembly – a requirement for the cover being removable. Next comes an inner hood made of stainless steel whose surface reflects heat radiation, thereby ensuring homogenous distribution of temperature in the pump head.

The third layer is a fiberglass fleece, which is protected by a plastic hood (the fourth and final layer). Finite element calculations were employed in the design of the head insulation.

Flame ionization detector

Flame ionization detectors (FID) are instruments that determine the total volume of hydrocarbons in air, exhaust air, or process gases. They are what make it possible to monitor processes in industrial plants. At the time of analysis, organic substances in a sample are cracked (split) in a hydrogen flame to create hydrocarbon fragments that oxidize into CHO^+ ions. The ion current between an anode and a cathode is proportional to the level of hydrocarbons in the sample.

A measurement gas pump feeds the sample of gas to the hydrogen flame. In this example, the manufacturer of the flame ionization detector uses a slightly modified pump model N 012.26. The pump is temperature resistant and has a heated pump head with electronic temperature control up to 240 °C.

The pump's control electronics are designed to be very practical in use. Using the pump's operating panel, the user can set the desired head temperature, the duration of a heating cycle, start time, and a hysteresis. Hysteresis indicates the number of degrees the actual temperature may fall below the set temperature before the heating element begins heating. The hysteresis function and the preheat mode are both designed to improve process safety. When preheat mode is activated, the pump will begin operation only once the desired operational temperature has been achieved in the pump head. This prevents pumping of the medium while it is still possible for components of the medium to condense out. Up to five heating cycles can be entered, so the pump can be operated without manual intervention even when several different head temperatures are required due to alternating media or pumping conditions.

However, temperature can be controlled not only at the pump. KNF's internally developed control software takes advantage of the pump's RS232 interface so the user can operate the pump and its heating directly from a personal computer. For every heating cycle, the software saves the values entered for duration, start time, set temperature, and hysteresis temperature in conjunction with actual temperatures, which the integrated measurement sensor records during measurement cycles in the pump head. This feature is a major benefit for documentation and quality assurance purposes.