E D U R - Multiphase Pumps Innovative Pump Techniques for Handling of Liquid-Gas Mixtures and for Generation of Dispersions

Joachim Thiele
Director of Exports
EDUR-Pumpenfabrik Eduard Redlien GmbH & Co. KG
Hamburger Chaussee 148-152, 24113 Kiel
Tel: +49 431 689868
Fax: +49 431 6898800
email: info@edur.de
website: www.edur.com

The typical purpose of centrifugal pumps is the transport of pure liquids. However, this ideal application is not often found under real working conditions. In many cases the pumps also have to transport undissolved gas or vapor. The reasons for this may be inadequate installation, like slight leakages in the suction pipe lines, or insufficient liquid levels above the inflow of the suction pipe line in open systems etc. On the other hand, process-bounded requirements must be considered when presence of gas is desired.

In a great number of engineering applications, multiphase media may occur and must be moved. Generally liquids have to be charged with gases, liquid-gas mixtures have to be pumped and gas-emitting liquids must be reliably delivered.

Under such conditions, ordinary non-selfpriming centrifugal pumps either break down or do not allow reliable operation. Such failures basically have their roots in the impeller design. With increasing gas content, more and more stationary gas is created at the center of the impeller. This finally blocks the impeller entry of liquid and interrupts the supply output. Even with slight gas content, the characteristic curve is no longer stable. Therefore, standard pumps are not suitable for such difficult working conditions. Process automated applications especially require controlled and trouble-free pump operation.

Today difficult applications like these are solved by the use of EDUR multiphase pumps.

Demands on Multiphase Pumps

The hydraulic parts of EDUR pumps have been specially designed to cope with problems which arise by handling of gas-loaded liquids. When liquids and gas are fed by separate suction lines, thorough mixing of both streams is attained resulting in a high degree of dispersion in the EDUR Pump.

Further characteristics of the pumps include: low wear by the inevitable contamination of liquids with solid particles, steady pumping characteristics by changing points of operation, and sufficient blending of liquid and gas to either obtain micro gas bubbles or achieve maximum gas entrainment (Fig. 1).

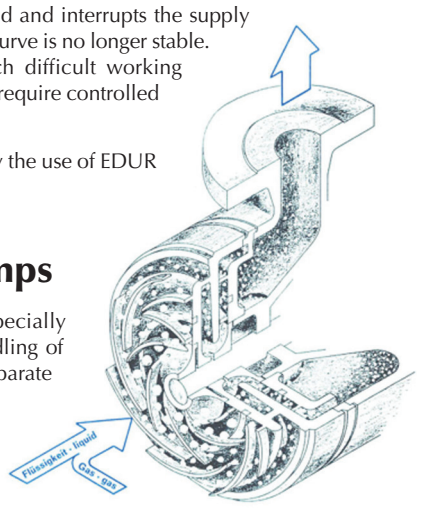

Figure 1: Principle of Feeding Multiphase Pump

The Principle of Operation and Constructional Features of the EDUR Multiphase Pumps

Depending on the pump model selections and gas content in the liquid, rates of flow up to 70 m³/h and pump pressures up to 28 bar can be achieved.

The pump characteristics are mainly determined by the amount of gas included in the liquid. The amount of gas included affects capacity, pressure and power input. With increasing gas content within the liquid, pump capacity and pressure will decrease as well as power input (Fig. 2).

Depending upon the model of pump selected, gas contents up to 30 % can be achieved successfully. In process engineering it is a definite advantage to be able to obtain stable operating conditions over the entire extent of the characteristic curve.

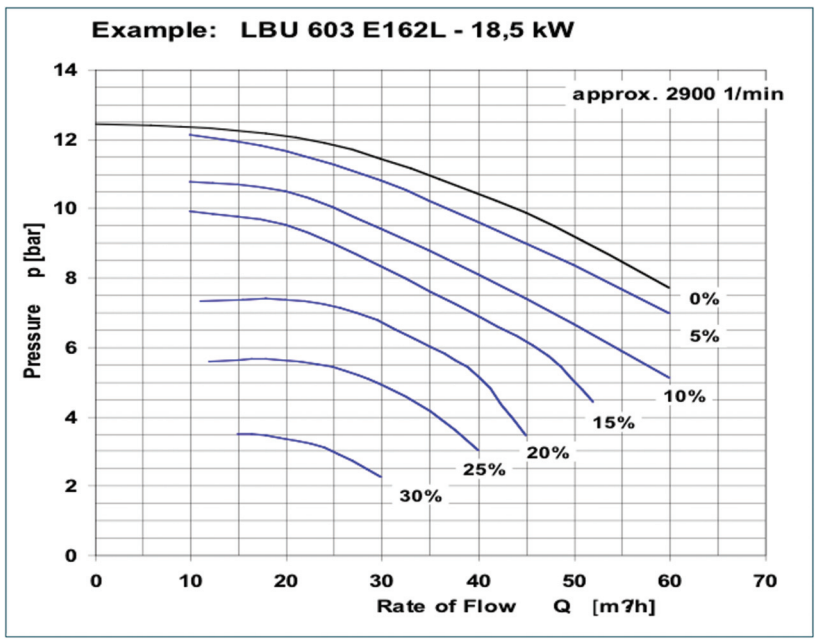

Figure 2: Performance curves for LBU603E162L in relation to degree of air volume contents

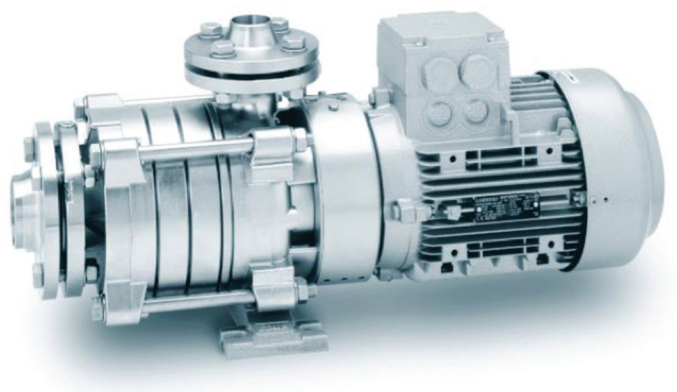

Figure 3: E D U R - Multiphase pump Super duplex execution

The distinctive feature of EDUR multiphase pumps is the impeller, open at both sides, combined with an appropriate hydraulic design (Fig. 3). The amount of permissible gas content depends on the width and diameter of the impeller as well as the number of stages of the pump. Premature pump wear is prevented by constructive measures combined with selection of suitable materials.

Pump selection problems are solved by the possibility of varying the number of stages and size of impellers.

Gas-Charging of Liquids

Because of the diverse properties of EDUR multiphase pumps, they can be used in many different applications, such as the loading of liquids with gases.

In the past, air-charging has been done by a costly concept consisting of compressors, pressure tanks, normal centrifugal pumps and an extensive control system.

For the first time, a clear reduction of system components can be achieved with the EDUR multiphase pumps, as only the pump is needed. The feeding of the gas is fed directly into the suction line of the pump. As the pressure of the available gas is below the pressure of the fed liquid, the pump only has to be throttled accordingly at the suction side to ingest gas. It is not necessary to increase the gas pressure above atmospheric pressure. The control by throttling goes analogously for frequency controlled pumps in which the pressure setting at the suction side has to be readjusted accordingly to speed variations.

By gas-charging, the pump function not only consists of delivering the two phases, but also works as a dynamic mixer and thus a certain portion or all of the gas is dissolved.

With different processes various kinds of liquid and gas will occur.

Dissolved Air Flotation for Purification or Waste Water

Waste water with a high degree of contamination charged with available atmospheric air or ozone and subjected to high pressure (Fig. 4).

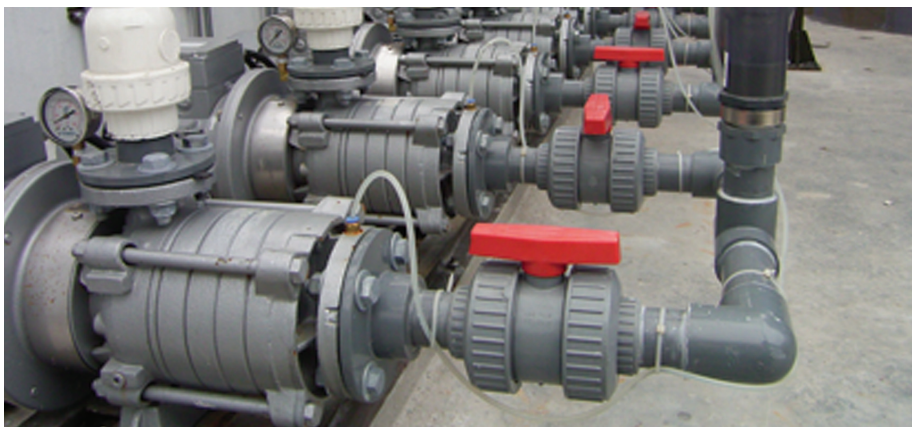

Figure 4: Innovative dissolved air flotation unit with EDUR multiphase pumps (illustration supplied by: MGCC)

Gas-Charging

The air or oxygen content of water is increased.

Neutralization

Alkaline solutions are neutralized by carbon dioxide.

De-Ironing

Ground water is treated with oxygen in order to remove iron and manganese at a water works.

Figure 5: Liquid-gas mixture generated by EDUR multiphase pumps

De-Nitrification of Waste Water

By means of hydrogen, nitrates are removed from pre-cleaned waste water.

Depending upon the type of process, gases with different properties are being used. For the correct selection of pumps, the solubility of the gas used together with existing liquid is of great importance. For example, the solubility of air in water is much worse than that of ozone or carbon dioxide in water.

Excellent mixing of liquid and gas is decisive for the quality of the process and consequently for the efficiency of the complete installation. Grades of solubility up to

100 % can be achieved with EDUR multiphase pumps. The result is shown as an excellent dispersion (Fig. 5).

Example: Dissolved Air Flotation

Dissolved air flotation is a reliable and accepted process for the purification of waste water thereby saving valuable matter. It is used for the easy separation of suspended resp. emulsified solids in liquids.

When water saturated with air under high pressure is reduced to normal pressure and conducted into the waste water tank, the micro bubbles ascend with the pressure reduction, attracting suspended particles and floating them to the surface where they are skimmed away (Fig. 6).

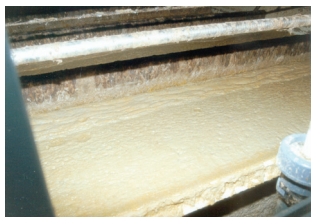

Figure 6: Flotate generated with EDUR multiphase pumps (food processing industry)

Size of the Micro Bubbles

In order to capture a maximum of flotate, it is necessary to generate micro bubbles as fine as possible and with equal distribution. Depending upon the waste water composition, EDUR multiphase pumps achieve a dispersion with bubble size smaller than 30 microns.

Quantity of Gas

The maximum solubility of air in water basically depends on the saturation pressure, the water temperature and the water quality. For flotation, as much air as possible must be dissolved and a surplus of air has to be avoided, resp. controlled. Also, with regard to the gas quantity, the flotation process is optimally supported by EDUR multiphase pumps. The grades of solubility are up to 100 %. Even with changing rates of flow and gas contents, the pumping characteristics remain steady so that it is possible to achieve exact pump control and adjustment to the flotation process.

The main feature of all EDUR multiphase pumps is that during the increase of pressure inside the pump, a sufficient blending of liquid and gas and an excellent saturation is obtained. By installing a pipe of sufficient diameter and length or an adequate pressure vessel on the pressure side of the pump, it is possible to increase the saturation accordingly. Consequently, a highly saturated water is available for an optimal process of dissolved air flotation where even the smallest particles are forced upward.

Typical fields of application are the treatment of oil-water emulsions, fat separations, phosphate and heavy metal precipitation and final sedimentation at biological treatment plants. Furthermore multistage flotation plants are known for the treatment of special waste.

OEMs report reduction costs of between 30 % and 40 % when using EDUR multiphase pumps both with regard to the investment volume and the operating costs depending on the type of installation compared to the traditional units (Fig. 7).

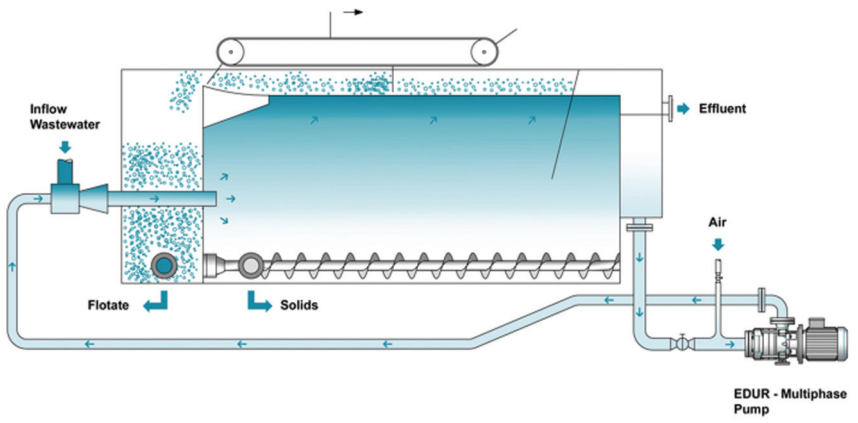

Figure 7: Structure of a dissolved air flotation unit in principle with EDUR-Multiphase Pumps

Application Transport of Liquid-Gas Mixtures

It goes without saying that outside of gas charging of liquids, already existing mixtures can be moved by multiphase pumps. In such cases, the contribution of the pump is the reliability of the process.

Summary

The technical and economical advantages compared with traditional solutions become particularly evident when liquids are to be charged with gases. Grades of solubility up to 100 % guarantee superior effects. In addition, the costs of equipment can be reduced considerably due to the fact that gas can be fed directly into the pump and auxiliary pumps or compressors for gas feeding become unnecessary. But economical operation is not the only gain offered by multiphase pumps. Another important benefit is the high degree of reliability, whether simple de-ironing installations or extensive waste water treatment plans are considered.