The Use of Hydrodynamic Sealed Pumps in Ammonium Nitrate and Urea Melt Applications

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Abstract

Bungartz horizontal centrifugal pumps with hydrodynamic shaft seals have proven to be very reliable in applications of the fertilizer industry. The hydrodynamic shaft seal works frictionless without any wear which contributes to high reliability and low maintenance cost. Furthermore no additional heat is introduced to the system, leading to a higher safety of the pump process. The hydrodynamic seal is leak free during operation and does not require any additional sealing liquid. With special modifications this type of pumps are especially suitable in Ammonium Nitrate and Urea Melt applications. The presentation will explain the working principle of the hydrodynamic shaft seal, point out the advantages in Ammonium Nitrate and Urea Melt applications and give some typical examples for the use in such applications.

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Introduction

When selecting a centrifugal pump for a feed task in the chemical industry, various criteria must be taken into consideration in addition to the pump delivery head and the delivery volume.

Some of these criteria are:

- Sealing of the rotating shaft with respect to the stationary housing
- Selection of suitable material and appropriate construction
- Selection of suitable accessories for starting, shutting down and safe operation of the pump

In the classical single stage centrifugal pump the impeller (which feeds energy to the pumping medium) is seated projecting on one side on a rotating shaft. This shaft is guided in bearings. A stationary casing surrounds the impeller. However, the shaft projects out of the casing. A gap between two parts with mutual relative movement must here be sealed.

This can be achieved with:

1) a gland packing with sealing water
2) a hydrodynamic seal (with downstream gland packing)
3) single or double mechanical seal
4) magnetic drive
5) canned motor

Each kind of seal has advantages and disadvantages. The hydrodynamic seal has proved to be eminently successful for pumps in the fertiliser industry.
Therewith a pump is available which

- requires little maintenance
- is wear free (in the region of the shaft seal)

and permits trouble free continuous operation.

**Functional principles of the hydrodynamic seal**

In addition to the "normal" semi-open impellers these impellers of pumps with hydrodynamic seal have additional back vanes. These additional vanes generate pressure which opposes the pump pressure.

In pumps with hydrodynamic sealing these back vanes generate a higher pressure than the normal blades (the normal blades are shorter than the back vanes).

Thus during operation no liquid reaches the gland packing. Therefore the gland packing is not required during operation. If it were technically possible, the gland packing could be removed and nevertheless no leakage would occur.

Due to the fact that the gland packing is not actually in use, a centrifugal governor has been integrated in the Bungartz pumps in the thirties of the last century. This governor is accommodated in protected manner in the bearing block and shifts the shaft towards the suction nozzle during operation. Since the shaft sleeve and the packing are conical, a gap between these two parts is created, and the packing thus runs without contact and without wear.
This has eliminated all disadvantages of a gland packing. Maintenance of the packing (such as readjustment) is not required. No sealing water is necessary and no leakage takes place.

<table>
<thead>
<tr>
<th>Bungartz Pump</th>
<th>Pump with packing</th>
</tr>
</thead>
<tbody>
<tr>
<td>•No friction between packing and shaft</td>
<td>•Friction between packing and shaft</td>
</tr>
<tr>
<td>•No lubrication required</td>
<td>•Lubrication required</td>
</tr>
<tr>
<td>•No lubrication required</td>
<td>•wear</td>
</tr>
<tr>
<td>•No leaking during operation</td>
<td>•Leaking not avoidable</td>
</tr>
</tbody>
</table>

Because with suction heads greater than 5-6 m the difference between normal blades and the back vanes would become very large, a modified variant of the pump type exists for this case. Here an additional seal expeller is fitted downstream for the sole purpose of sealing against the pumping pressure.

By circulating a small partial stream, an additional circulation nozzle (connected to the suction line or to the suction container) prevents concentration of solids and heating up of the medium in the rear part of the pump.

This form of the seal is in use for over 80 years and is far superior to the mechanical seal for non-toxic media.
Applications

In the fertiliser industry these pumps are utilised for:

- Phosphoric acid
- Sulphuric acid
- Nitric acid
- Melts (for example ammonium nitrate or urea)
- Solutions with solids (ammonium nitrate with dolomite)

Long service lifetimes are achieved by selecting suitable materials and appropriate constructions. In the version with wear plates the latter can be made of a particularly hard material (this could impair casting). The procurement cost of the pump is higher, but the maintenance costs are lower because it is no longer necessary to replace the complete expensive pump casing.

The pump depicted in the following illustration for a 96-98% ammonium nitrate melt is intended to show how the pumps from Paul Bungartz GmbH&Co.KG are adapted to the special conditions of utilisation.

The heart of the device is the hydrodynamic seal. Thus no frictional seal is present which could lead to an explosion with this medium. The steam jacket prevents cooling down of the melt below its solidification point. Temperature sensors ensure that there will be no excessive heating in the case of a failure situation. After switching off the pump can be emptied via the drain valve. This prevents crystallisation of the medium in the pump.
A similarly adapted construction is also available for urea melts.

**Summary**
By using the hydrodynamic seal and a construction adapted to the medium, pumps can be built which provide the operator with a long service life.