

## ATEX-compliant pump speed control for outputs from 270 watt to 7.5 kW

(Translated specialist report – published in German in the pump magazine "Δ p 1/2005")

When we think of controlled pump drives we almost always think of frequency converters. However, under ATEX conditions, the then necessary precautions cause an increase in costs. Hans-Joachim Wunn, Managing Director of planetroll GmbH in Munderkingen, recently brought our attention to a fascinatingly simple and highly economic alternative (Δ p 3/2004). His company builds variable-speed gearboxes for pump drives with impressive performance data and particularly economic performance under ATEX conditions.

"We do not have to externally monitor our gearbox units as the system design makes it impossible for these gearbox units to slip through. And this saves the owner/operator very substantial monitoring costs. These variable-speed gearboxes can be directly used in Zone 1 or Zone 21 just as they are when they leave the factory," says Hans-Joachim Wunn, Managing Director of planetroll GmbH in Munderkingen.

Planetroll is the inventor of variable-speed gearboxes which are based on a special type of rolling bearing gears, so-called ball gearboxes. With these gearboxes we can adjust the speed of pumps in a controlled way, mechanically and fully stepless down to zero speed, manually as well as electronically, i.e. by remote control. "With our gearboxes the output shaft and thus the pump can be controlled to a standstill, although the drive motor is running with design speed", says Wunn, "and that is unique in the world." Of course, it can also be used to start-up stopped pumps again, whereby the speed can also be changed at a standstill. This gear technology is based on elasto-hydrodynamic power transmission. "These variable-speed gearboxes are based on a very complex, but nevertheless extremely robust technology. The high technological level is reflected in the fact that no other company has yet managed to copy these gearboxes."

Yet large competitors only come from the electrical engineering - electronic side. Frequency converters, which compete with the variable-speed gearbox, have become more and more powerful; the variable-speed gearbox was able to participate in the trend to increasingly more speed controlled pump drives to a small extent only. This now appears to be changing, since the ATEX Directive became valid for a large number of pump drives. In these cases, the mechanical variable-speed gearbox is obviously the most cost-effective and robust solution. For almost two years now, ATEX has been binding for all manufacturers of equipment used in potentially explosive areas. This now applies, as is generally well-known, especially to mechanical components; they must be so safe that, depending on the individual classification zones, they do not cause any risk of explosion.



The ATEX variable-speed gearbox plaromaster® from planetroll



plaromaster® variable-speed gearbox with downstream planetroll ATEX planetary gearhead planetdrive®

Planetroll defined these requirements as the basis of the development of its whole gear series. "As far as I am aware, planetroll is the only gear manufacturer to have specifically developed a new series precisely according to the ATEX 95 requirements. As we had already intended revising our variable-speed gearboxes, we were lucky that the ATEX definitions appeared precisely within this period. The size of our company, with around 40 employees, has also proven to be a decided advantage, as with our small team we are able to very flexibly respond to new challenges. Our current variable-speed gearboxes are therefore consistently designed to the ATEX requirements – in no way whatsoever do they represent a compromise dependent on old products. A further decisive advantage is that our gears are the only ones with an intrinsically safe character. We do not have to externally monitor our gearbox units as the system design makes it impossible for these gear units to slip through. And this saves the owner/operator very considerable monitoring costs. The planetmaster variable-speed gearbox, whether adjustable using a hand wheel or often electronically adjustable by remote control, can be used directly in Zone 1 or Zone 21 in precisely the same form as they left our factory. This does not apply to many friction drive or adjustable belt drives still used. These have the decisive disadvantage that they slip through in the event of an overload or blockage. The planetroll variable-speed gearbox definitely does not slip."

These variable-speed gearboxes provide an extraordinarily large torque from zero speed, i.e. from a standstill. The torque, without damaging the gear, is so large that the motor's starting or pull-out torque can be considered to be the limit value for the load. "As the motor and gear are always designed to match each other as a unit, the planetroll gearbox always provides the torque the motor is capable of achieving. Frequency converters of the same size do not achieve these extraordinarily large torques.



Variable-speed gearbox with ATEX motor "Increased Safety" for Zone 1 and Zone 21



Variable-speed gearbox with ATEX motor "Increased Safety" for Zone 1 and Zone 21 and electric remote control for speed adjustment

Larger frequency converters must be used, which then achieve these large torques but a clear cost disadvantage would then have to be accepted. In addition, frequency converters heat up considerably when they operate within the range of the smallest frequencies and they are not able to control down to zero speed. Furthermore, frequency converters also affect the electricity supply and always have to be considered under the EMC and Low Voltage Directives."

90 % of all planetroll variable-speed gearboxes supplied for explosion-protection use are today used in Zones 1 and 21. Drive motors with "increased safety" certification are fully adequate for this, i.e. "explosion containing" motors are not required. "However, frequency converters with the same constellation for Zones 1 and 21 do indeed have to operate with "explosion containing" motors, i.e. a further substantial cost advantage for our variable-speed gearboxes", says Wunn.

Planetroll produces all its variable-speed gearboxes according to ATEX requirements. "This ATEX standard specification for all our gears," says Wunn, "has naturally caused a high degree of testing and documentation, but at the same time it has resulted in considerable streamlining in production, stores management and logistics, which enabled significant price cuts in recent years. With this platform strategy we offer customers who do not have any ATEX requirements the guarantee of extraordinarily high quality and all our ATEX and NON-ATEX customers enjoy the large cost advantage of this concept."

The decision to base all series on the ATEX requirements required substantial development efforts. "Due to the unique character of our gear design we were unable to prove ATEX conformity using software-aided simulations and calculations. This meant we had to carry out test series over the whole speed range for all gear sizes, for each possible add-on motor output, each mounting position and all approved input speeds. For 3 years we ran continuous load tests day and night, necessary according to DIN EN 13463 ff., and documented the results down to the smallest detail. On 1.7.2003 we were then able to present a complete redeveloped and ATEX-compliant range of variable-speed gearboxes."

Under the ATEX regulations a gear manufacturer must also check what happens if gradual oil loss occurs. Under ignition source aspects the usually resulting heating up is very critical. With tests, planetroll was also able to document that this leakage situation is completely uncritical for these variable-speed gearboxes. "This is because", says Wunn, "in this case cold welding, i.e. a permanent metallurgical connection, of the balls with the raceways occurs within fractions of a second and stops the drive. Heating does not occur."

Apart from ATEX 95, which is the decisive EU explosion protection Directive for manufacturers of equipment, since 1.7.2006, ATEX 137 has played an equally large role for plant owners/operators. From this time the plant owner/operators must prove in so-called explosion protection documents that the plants operated are safe under ATEX aspects and everything possible has been done to ensure they are safe.

"This changeover also results in important tasks for us", says Wunn. "With our ATEX know-how we can help plant owners/operators to implement ATEX 137. We provide support, especially for the analysis of pump drive weakpoints under ATEX aspects ... and of course to offer our ATEX compliant variable-speed gearboxes too."

"ATEX results in costs for all companies involved – from the manufacturer through to the owner/operator. Manufacturers often tend to shift responsibility for the ATEX-conformity of their products into the operating instructions and thus onto the owner/operator. From my point of view, pump owner/operators are frequently confronted with almost unreasonable regulations for monitoring and maintenance of the drive units, which they are unable to shoulder. Due to the particular suitability of our variable-speed gearboxes we are able to dispense with very many monitoring obligations, which help to minimise downstream costs and time. We consider our variable-speed gearboxes, including the operating instructions, to be the most user-friendly drive solutions under ATEX aspects," says Wunn.

The complete planetroll gear series includes 7 sizes for drive outputs of 270 watt to 7.5 kW. These gears have a very high specific output, so that very small variable-speed gearboxes are also available for the restricted conditions in laboratory and technical college applications. And on the other hand there are virtually no upper limits to their performance. The combination of the largest planetroll variable-speed gearbox with a matched motor and downstream speed reducer, output torques of over 50,000 Nm are achieved! With such unusually high torques from zero speed and at low speeds, these variable-speed gearboxes are used for example on fishing trawlers, to slowly lift the full nets on board. A high, if not so exorbitantly high starting torque is also necessary for pumps if breakaway moments have to be overcome, as is the case in many uses of e.g. eccentric screw pumps. These can also occur in all other types of pumps, which pump for example highly viscous through to pasty media or media which tend to sediment out.

Planetroll variable-speed gearboxes have a very linear adjustment characteristics, high synchronism and high stiffness. All gears are coaxial gears, which can easily be operated with 2, 4 or 6-pole motors, with NEMA connections too of course. These gears run in a clockwise and anti-clockwise direction and as a standard have IP65 degree of protection. They have a completely smooth, easy to clean surface. On the one hand this fulfils the ATEX requirement of preventing dust deposits as far as possible and on the other hand this smooth surface provides ideal prerequisites for using these variable-speed gears under GMP and FDA standards too. "With our gears, pump manufacturers can submit a complete offer, by building the variable-speed gear directly onto the pump, in precisely the same form as it was delivered from the factory. Absolutely no monitoring function, wiring or expensive additional equipment is required, not even for hygiene applications."

These drives can also be used in plants under extreme climatic conditions. Planetroll recently supplied variable-speed gearboxes which have to reliably operate up to  $-35\text{ }^{\circ}\text{C}$ . The traction fluids used for these variable-speed gearboxes are specially modified for such extreme requirements. "It is easy to imagine what conditions prevail under such climatic circumstances. This is definitely also an environment in which mechanical variable-speed gearboxes are substantially more robust and insensitive than, for example, electronic frequency converters. The robustness of the variable-speed gears of course makes them suitable for other use conditions too, in which the operating personnel's qualifications are not so high and pump drives have to run continuously, if possible without servicing and support." The speed range of these variable-speed gearboxes can therefore also be limited as an option. This is realised either via the electronic control or via a small mechanical component which can also be subsequently attached or can be realised mechanically in the factory by installing it inside the gearbox.

"With all these properties," says Wunn, "we offer extremely attractive speed control possibilities, especially to pump manufacturers and pump owner/operators who have to work in compliance with ATEX. In this variable-speed gearbox segment we are certainly already the market leader and will continue to expand this position."

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#### The mechanical speed controller

Since 1998, planetroll, with its head office and production facilities in Munderkingen, Upper Swabia, has been part of the INDUS Holding AG investor group, which is broadly diversified with more than 40 companies in all kinds of different areas of business. The previously high production depth, competitive pressure from frequency converter technology and the drop-off in prices for drive engineering in general have led to planetroll completely re-orientating itself in recent years under the leadership of Hans-Joachim Wunn. "We have reduced our production depth and replaced our previous gears with a completely revised gear series. The re-engineering started precisely within the period in which the ATEX regulations were also defined for non-electrical equipment. In this way we not only almost halved our type diversity, but above all were able to completely orientate our new series to the ATEX regulations. The reduction in parts and production simplifications have resulted in massive cost savings. And we pass on all these cost advantages to our customers."

The product range consists of the newly developed

- § plaromaster®, variable speed gearboxes,
- § planetdrive®, planetary drives - especially for the servo market,
- § plarotronic®, controls for variable-speed gears and
- § plaroTorque®, electronic document recording for the variable-speed gearboxes

Based on these, planetroll produces a whole range of controllable special gearboxes

"With the plarotronic we offer the same command and communications performance as frequency converters. Our variable-speed gearboxes are therefore BUS capable and can be integrated in process control systems. We can realise all control parameters with the plarotronic and the variable-speed gearbox. This leads to a completely new quality in the variable-speed gearbox itself and in its position on the variable-speed drives market. I can see good growth potential for the technology we supply, especially because it offers substantial explosion-protection advantages.