maag
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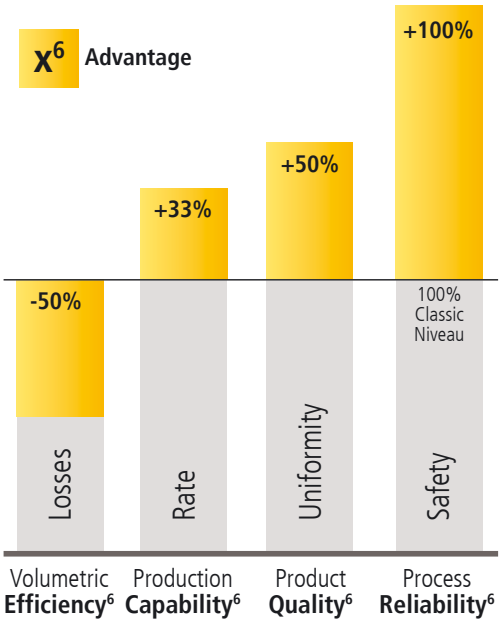
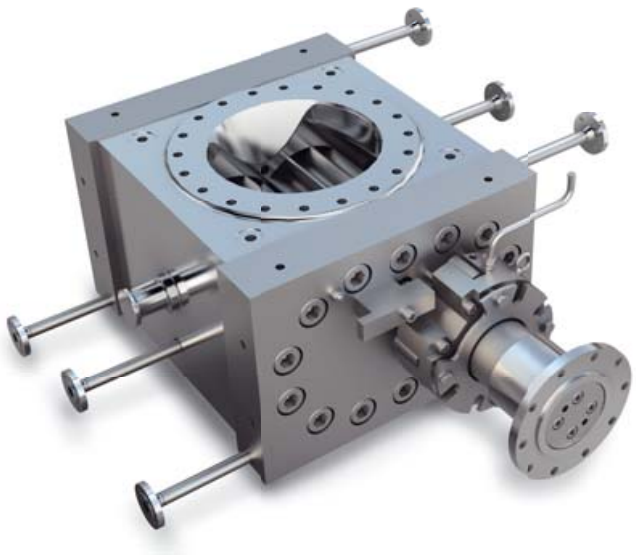
maag
pump & filtration
systems

x6 class

x6 CLASS GEAR PUMPS

Taking Gear Pump Technology to the next level





Maag breaks new ground in gear pump technology with it´s x6 class series of pumps.

The gear pump portfolio is designed to pump polymer melt in the most efficient way.

With the x6 class gear pumps, Maag redesigned every single component featured in its pump portfolio, from gears and shafts through to bearings and seals, fine-tuning how all components interact, culminating in a new industry-leading state of the art technology.

Product **Quality6**

- **Streamlined Linearity** Minimized intrinsic pump pulsation to maximize your product uniformity

Volumetric **Efficiency6**

- **Flow Economy** Reduced back-flow to lower your energy consumption
- **Protected Polymer** Minimized back-flow volume to speed up your polymer change

Production **Capability6**

- **Peak Rate** Superior flow capacity to boost your productivity

Power **Density6**

- **Small Footprint** Minimized Footprint to reduce your total cost of ownership

Process **Reliability6**

- **Smart Flow** Fast lubrication replacement to improve your process stability

CHALLENGE, APPROACH & FINDINGS

x⁶ class

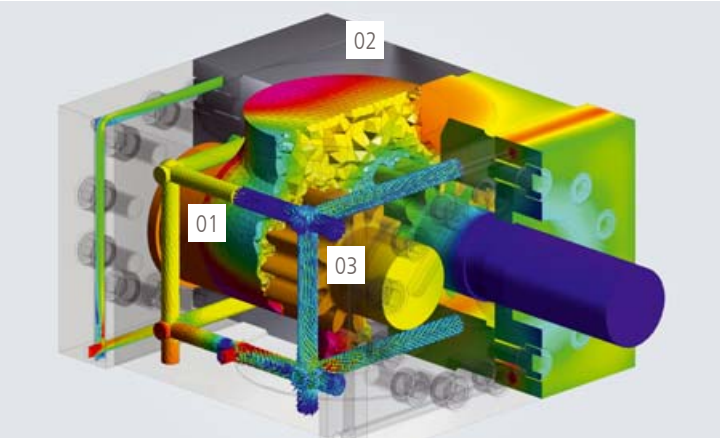
Challenge

A gear pump is a rather simple device that works volumetrically and consists of only a few key components, namely the housing, the gears, the bearings and the shaft seals.

As soon as one goes into the details, however, the complexity dramatically increases. Since the pump is designed to handle polymers, one has first to understand how such long-chained molecules behave under stress, e.g. they respond to high temperatures and shear rates, in particular when the residence time is long and or unevenly distributed, by thinning out while simultaneously degrading.

Naturally, everybody's goal is to optimize customer´s value for its product - in our case, the gear pump. This means - e.g. to achieve maximum efficiency while maintaining the lowest possible temperature increase in the bearings and product. Although decreasing the clearances does improve efficiency, one cannot simply tighten these since that will eventually not only compromise the product quality but also undermine the function of the pump itself (with the possible galling of the shafts and bearings inside the housing).

The ideal solution is complex and requires a holistic approach with a deep understanding of both mechanical and rheological issues coupled with a thorough knowledge of process technology so as to find this perfect balance between all the critical components.



Inhouse FEM analysis of stress, fluid dynamics, heat flux, etc. has been part of the optimization process

01 Improved bearing technology
02 Application specific housing options
03 Further optimized gear shaft geometry

Approach

Indeed, Maag has been successfully building pumps for decades and can look back on a heritage in gear manufacturing spanning no less than a century. While Maag undoubtedly benefits from its own pump and rheology laboratories, it has also long been known as a partner to its customers, designing products that are tailor-made to their specific needs, and accumulating priceless knowledge in the process. It engages daily in countless mutually beneficial relationships with customers around the globe, coming from all ends of the production spectrum. As a result, Maag has now processed many thousands of different polymers, and the whole experience has been carefully woven into the design program of the company. The result of this accumulated experience is a completely new pump design yielding outstanding results. No other pump generation has ever been as efficient as Maag´s newest pump - the **x**⁶ class.

Findings

Maag´s **x**⁶ class pumps market answers to customers dealing with;

- Installation space constraints
- De-bottlenecking (increase flow rate) in given space
- Necessary product quality improvement
- Reduction of energy consumption
- Need to increase the pump pressure for processing low viscosity polymer grades
- A broad polymer portfolio (considerable stretch between high to low viscosity grades)
- Requirements for a very steady flow (less pulsations)
- Desire to increase life time of the pump (reduced bearing temperatures) / have an extremely reliable pump
- The need for an optimized extraction solution, because extraction from reactors in processes with standard NPSH requirements (e.g. PET) differs from extraction in thermoplastic processes which needs to minimize the required liquid level of the connected vessel (minimum NPSH requirement)
- Requirements to further increase the torque load capability for higher safety during start up and operation and an increased general production security

CUSTOMER BENEFITS

x⁶ class

Benefit

- A vastly improved volumetric efficiency makes it possible to operate at reduced rpm, shear rates and temperatures, and consequently a narrower residence time distribution. This will favorably impact production rate, polymer quality, pump reliability and lifetime, while reducing energy consumption significantly, as losses are reduced by 50%.
- The advantage of an enhanced pump geometry will be welcomed by manufacturers of easily degradable products, in particular during degassing stages where minimum fill levels in the vessel directly connected to the pump translate into reduced residence time. Customers will thus be able to minimize the levels of volatiles in their products. Maag´s **x**⁶ class pump NPSHr value (required net positive suction head) is unbeaten as the enabling feature to meet these goals and can process polymer depending on the size of the pump, of up to 200'000 Pas (0- shear viscosity).
- Product quality is improved overall. Due to the enhanced pressure capabilities, finer filter meshes can now be used further down the line. And a higher volumetric efficiency and fewer pulsations guarantee a constant quality and output of the final product.
- Given its increased operating range, Maag´s new gear pumps will enable manufacturers to branch out into the production of a wider variety of products since one and the same pump can handle polymers, with viscosities varying by as much as 5 orders of magnitude.
- Maag also offers alternative housing designs for its polymer extraction pumps and also for polyrex compounding pumps, with matching interfaces to older pump generations. Thus, customers looking for dramatic cost-effectiveness while debottlenecking their existing plant will greatly benefit from the outstanding performance of this new generation, with minimum installation costs.
- Potential to use a smaller gear pump for a given capacity.

x⁶ class experience

Maag Pump Systems has been intensively developing and testing the **x**⁶ class gear pumps with focus on practical trials.

The first industrial **x**⁶ class pump was put in operation in 2013 for a wide range of viscosities between MI 1 and 1'000. The x6 class pump improves the pressure capabilities significantly. It enables the customer to produce the full range of desired polymer grades and in addition at higher flow rates than before.

Meanwhile, the **x**⁶ class has proven its benefits in many more applications in industrial scale, amongst others also for the biggest polymer pump in the world.

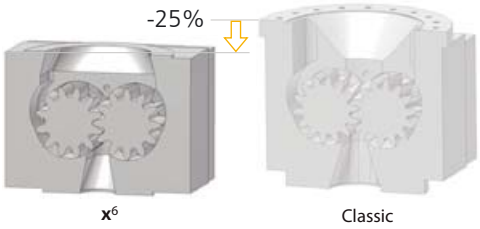
APPLICATION EXAMPLES

x⁶ class

Extracting PET out of reactors

x⁶ class is is more compact, easier to handle and pumps higher flow rates at identical process limits.

Example	VX 250-6 GU S	VX 280-M
Flow rate	100 %	100 %
Weight	75 %	100 %
Specific Volume	12,200 cm³ / rev	12,100 cm³ / rev



Improved pressure capability

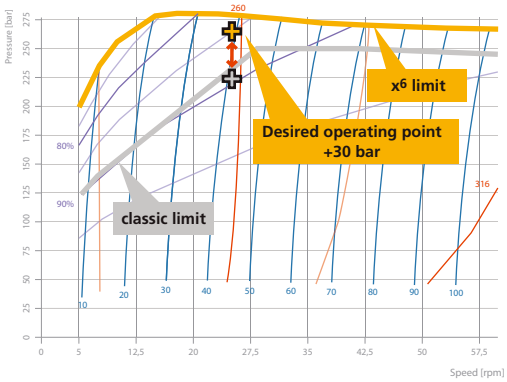
Situation: Processing of PP for demanding (high filtration) applications

Status Quo: PR 25 Classic with a specific volume of 17.5 liter: Filtration is limited by lack of available pressure

Target: Process optimization requests for finer filtration to achieve better polymer quality

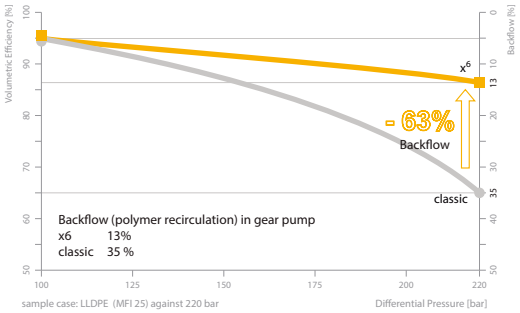
Solution: PR 320-6 EP with a specific volume of 20.1 liter

Conclusion: A pump with smaller overall dimension, having a similar specific volume can process a bigger polymer flow against a higher pressure



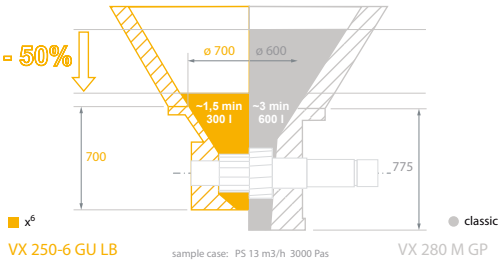
Volumetric efficiency improvement

- Enlarged operating window and process also lower viscous grades against a higher pressure
- Save up to 50 % on energy
- Reduced temperature increase of polymer by up to 10 °C



Extracting thermoplasts from vessels

The optimized pump geometry of the vaxore**x⁶** type LB reduces the required fill level and thus the necessary residence time in the vessel the pump is connected to. Depending on the vessel design, residence time is reduced by 50%.



Performance comparisons

x⁶		Classic	rpm	Δp	Installation height	Flow rate
TB 63-6 GU	**vs**	**TR 70-M GP**	+5%	=	-20%	+13%
VX 280-6 GU	**vs**	**VX 280-M GP**	=	=	=	+50%
TB 224-6 EP	**vs**	**TR 224-M BG**	=	+30%	=	+16%

All scenarios are assuming identical temperatures in the bearings as compared to operating with a classic pump. Statements are indicative only, as exact figures are depending on the specific operating conditions and polymer properties

maag pump & filtration systems

Global contacts, see **www.maag.com**
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