



## Unique Durable and Reliable Gasifier Feeding Pump

45 years of experience in development, manufacturing, assembly, commissioning and after-sales-service of gasifier feeding pumps

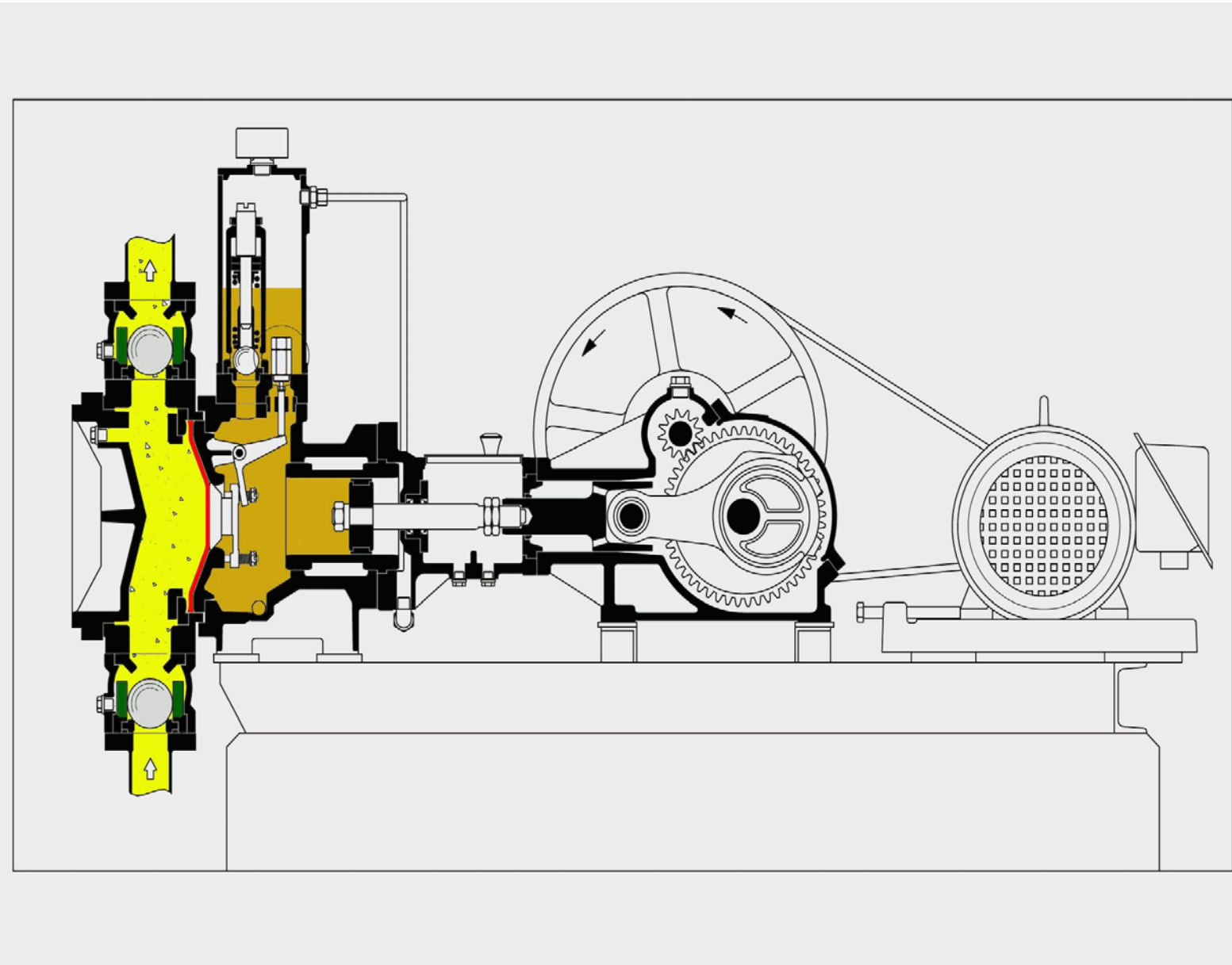
- *1973- 1975:*  
Development, production, delivery and commissioning of a tailored gasifier feeding test pump (diaphragm piston pump) for Lurgi (Germany) and Texaco Pilot Plant (USA) as well as on-site tests.
- Increase of availability by enhancing the supplied diaphragm piston pump into a double diaphragm pump.
- *1977:*  
Development and test of the unique FELUWA double ball valves in wafer design.
- Development of the second generation of hermetically sealed oscillating displacement pumps:  
the FELUWA hose-diaphragm piston pump – a pump which gained worldwide recognition.

- *2001:*  
In line with the continuous further development, enhancement of the technical and commercial value and improvement of plant availability, the 3<sup>rd</sup> generation of hermetically sealed oscillating displacement pumps was developed: the FELUWA MULTISAFE<sup>®</sup> double hose-diaphragm piston pump.
- Start the very successful cooperation with ENCORE/China
- The MULTISAFE<sup>®</sup> double hose-diaphragms achieve operation times of several years in continuous operation.
- The double hose-diaphragms of MULTISAFE<sup>®</sup> double hose-diaphragm pumps are no longer regarded as typical wearing part.

- *2003*  
Development of the FELUWA online diagnostic system (FVPMS = FELUWA Valve Performance Monitoring System)
- *2004*  
FELUWA obtains the ATP award for their Valve Performance Monitoring System
- *2003 -2012*
  - Continuous enhancement of the check valves, which nowadays achieve operating times of more than 16,000 hours.
  - In-house production of valve balls.
  - Development of TopEntry easy repair valves (upward instead of downward removal of valve trim) with FELUWA Quick Change device.
  - Development of Quintuplex MULTISAFE® double hose-diaphragm pump.

# Evolution of FELUWA MULTISAFE® Pumps

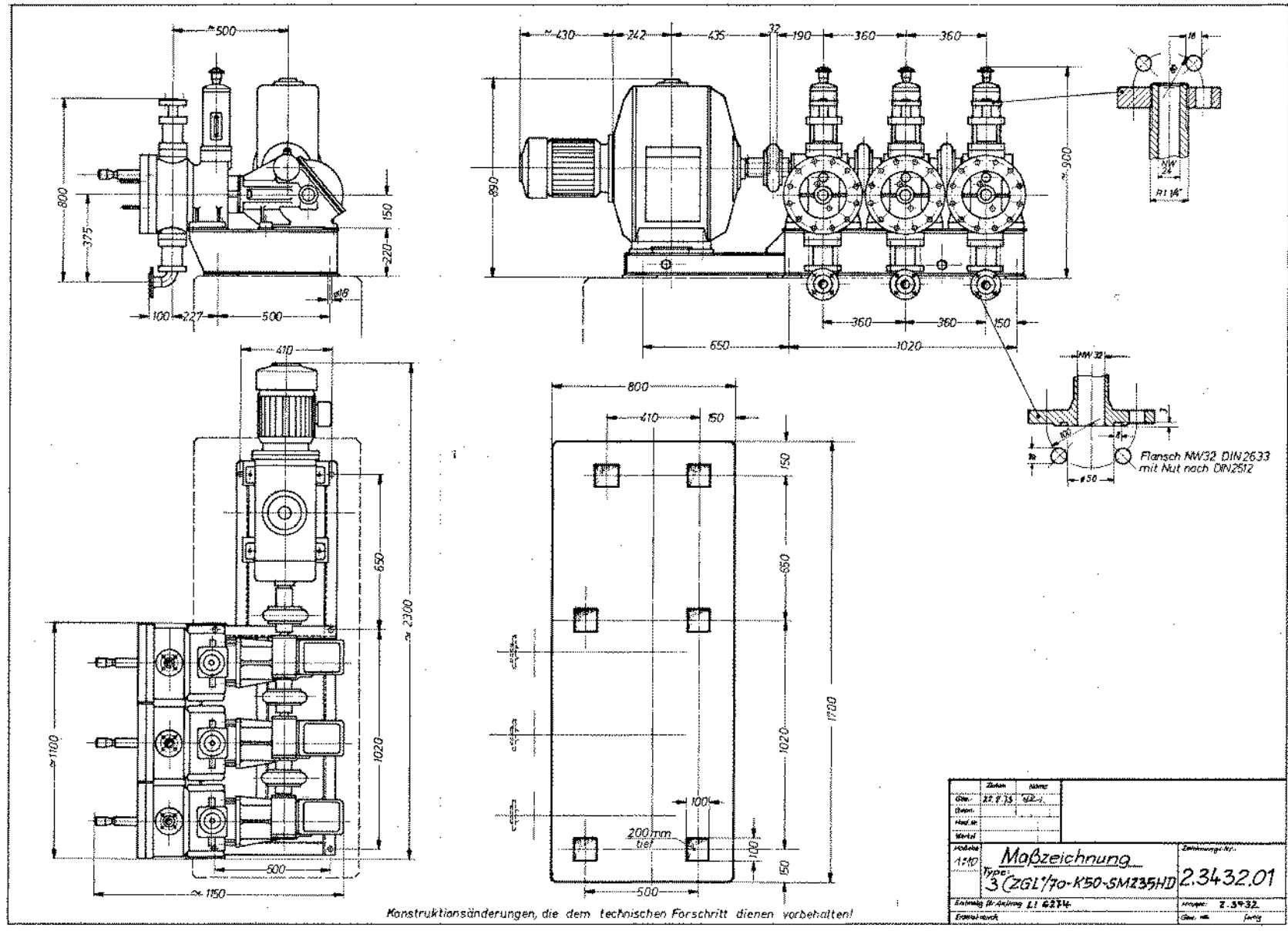
Diaphragm Piston Pump developed by FELUWA in 1960



***1973- 1975:***

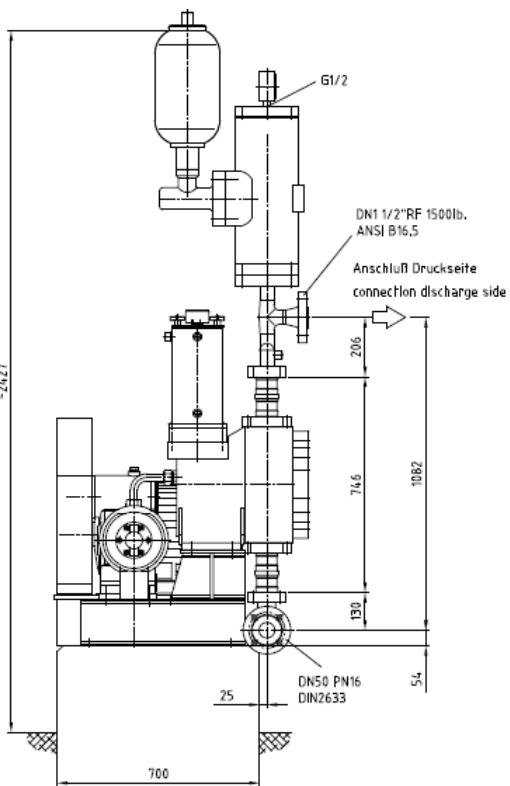
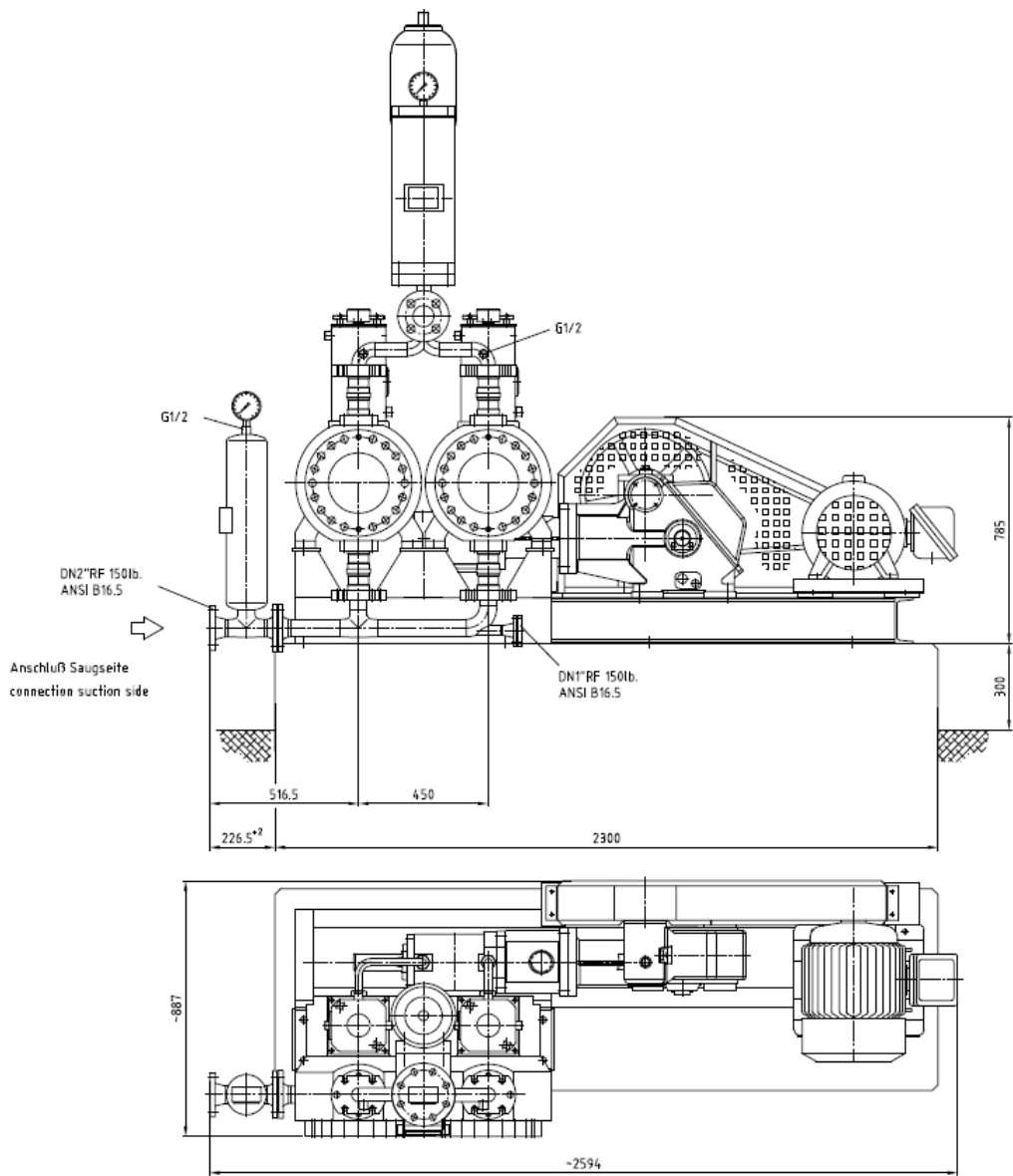
**Development, production, delivery and commissioning of a tailored gasifier feeding test pump (diaphragm piston pump) for Lurgi (Germany) and Texaco Pilot Plant (USA) as well as on-site tests.**

3 ZGL 1/70 – K 50 – SM 235 HD; 1 m<sup>3</sup>/h; 70 bar



# Arrangement Drawing Texaco

ZGL 15/100 - K 50 - 2 SM 235 HD; 0.223 m³/h; 138 bar



Fundamentplan 1.2630.017  
foundation drawing 1.2630.017

Schlauch-Membran-Kolbenpumpe  
hose diaphragm piston pump

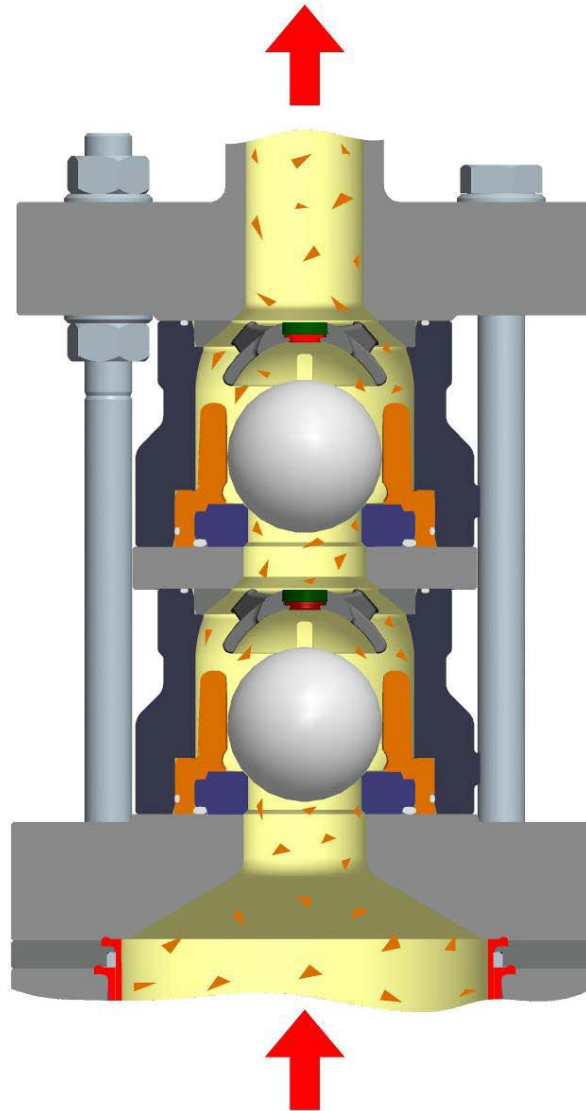
Hersteller/Manufacturer		Abgleichkriterium/Approval criterion					
Modell/Model		DIN ISO 2768 (mK)					
Genehmigt/Approved	05.06.02 Michels, C.	Schutzverfahren/Protection note					
Genehmigt/Approved	05.06.02 Späth, A.	ISO 18616					
Skizze/Scale	1:10	Beschreibung/Description		Zahlungs-/Drawing No.	1.2630.011	Revised	-
Format	A2	Schlauch-Membran-Kolbenpumpe		freigegeben		Sheet	1/1
		Hose Diaphragm Piston Pump					
		ZGL 15/100 - K 50 - 2 SM 235 HD					
Erstellt für Auftrag/First issue for order		21/103563/00		Genehmigung/Approval			



***1977:***

**Development and test of the unique FELUWA double ball valves in wafer design.**

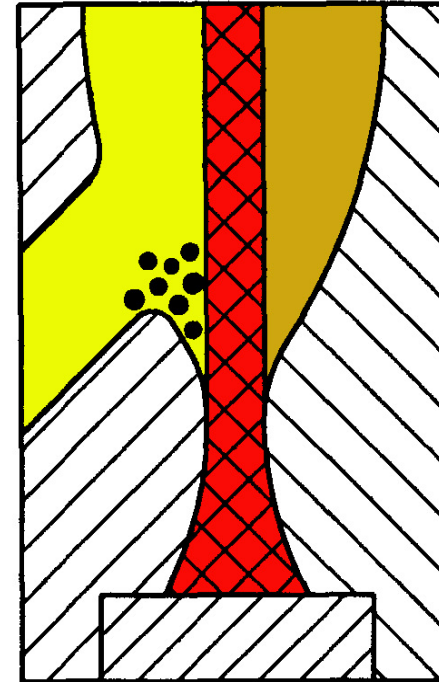
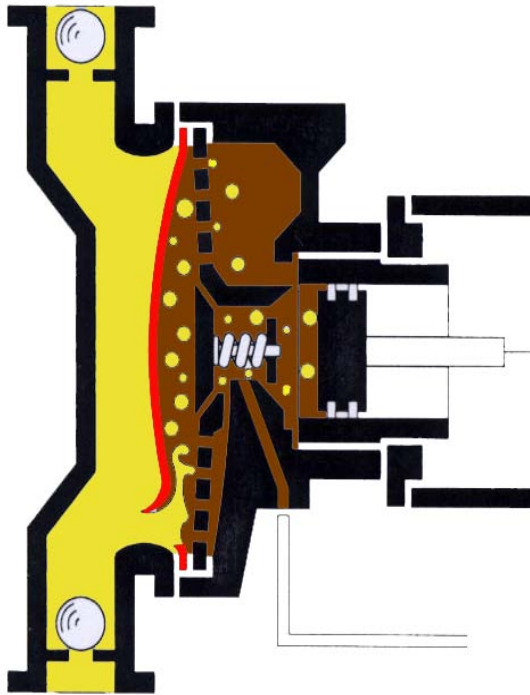
# Unique wafer type FELUWA Double Ball Valves



**1977:**

**Increase of availability by enhancing the supplied diaphragm piston pump into a double diaphragm pump.**

# Traditional Hydraulically Actuated Diaphragm Piston Pump Design



**Typical diaphragm clamping method**

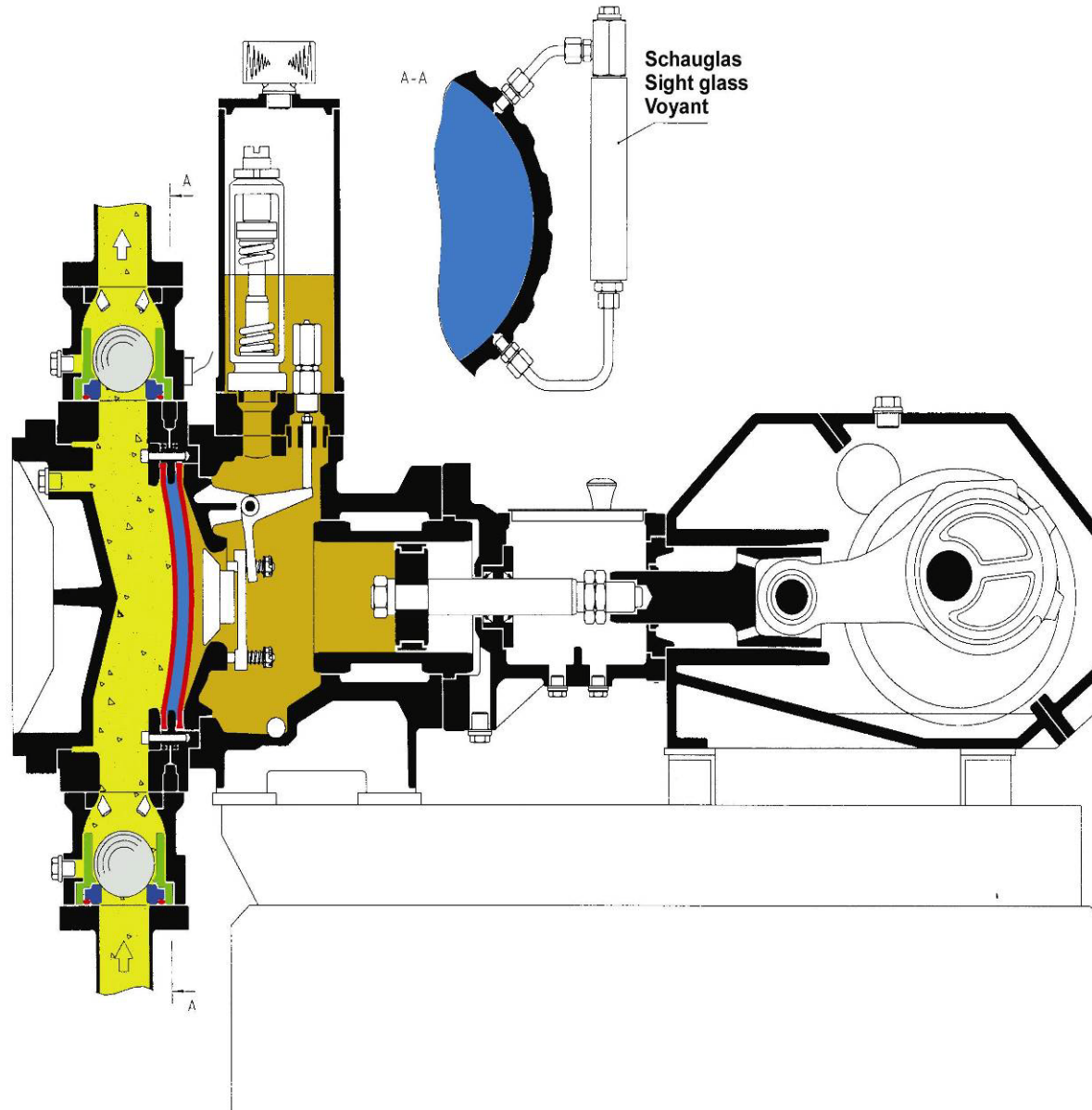
(Subject to sedimentation and damage in the clamping area.)

## Disadvantage:

Reliability of diaphragm piston pumps with single diaphragms is somewhat limited when handling chemicals or highly aggressive media. Media that is subject to crystallisation is particularly difficult for this type of pump. For example, solids will tend to settle within the lower part of the pump between the diaphragm and the diaphragm retainer ring. This leads to premature destruction of the diaphragm.

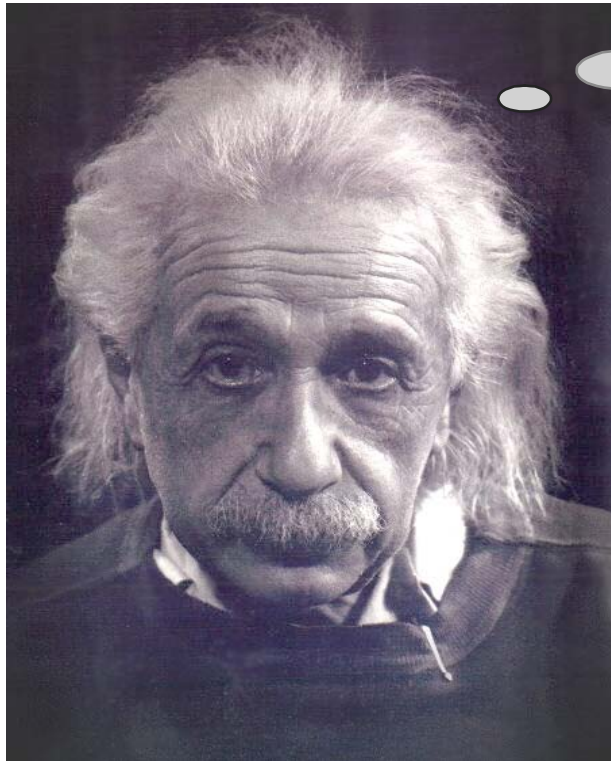
**Due to the design of this type of pump, the conveyed fluid will inevitably get into the hydraulic system as a consequence of diaphragm failure. There it comes into contact with sliding seals and the cylinder face, which may result in considerable destruction (costs !)**

# Traditional Double Diaphragm Piston Pump



**1972:**

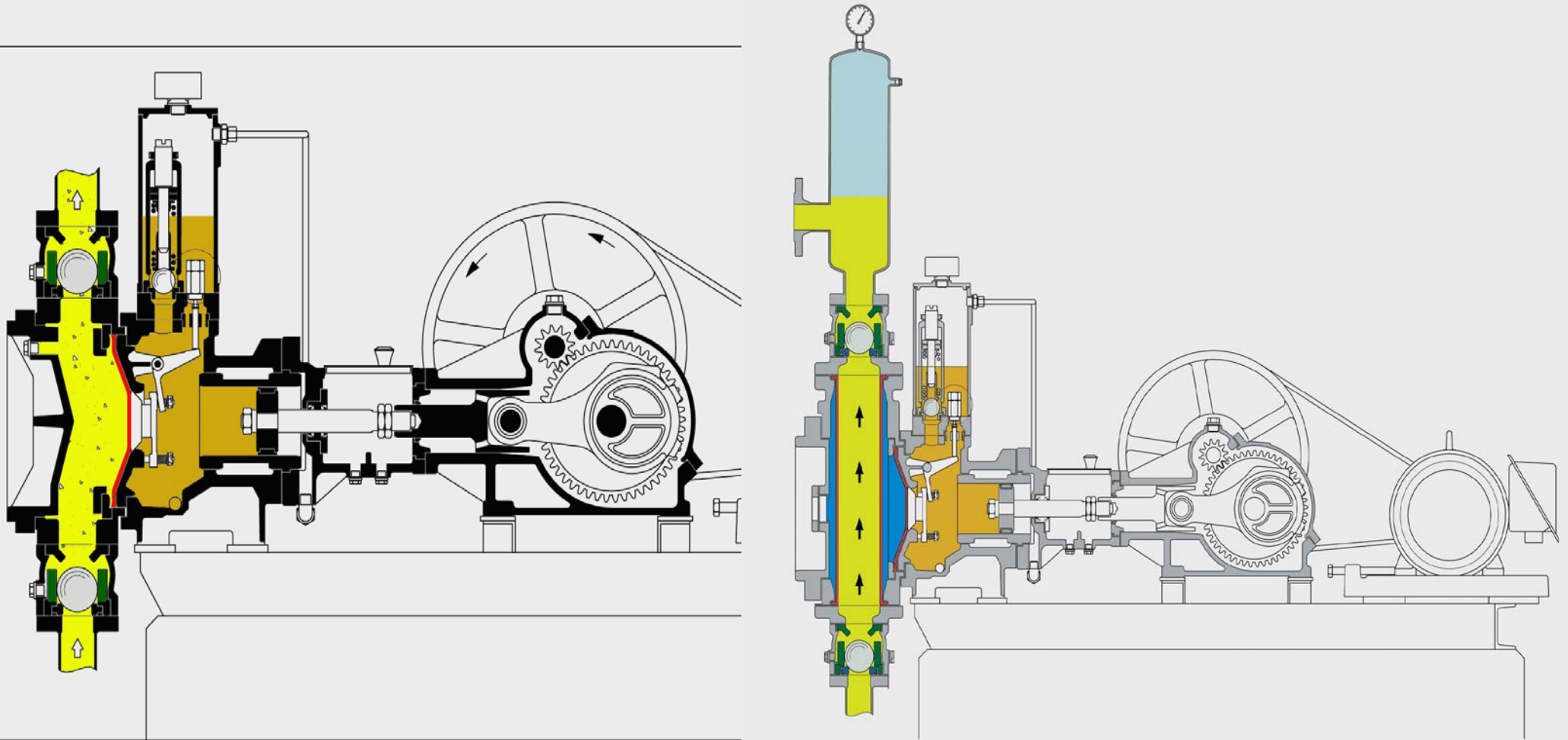
**Development of the second generation of hermetically sealed oscillating displacement pumps: the FELUWA hose-diaphragm piston pump – a pump which gained worldwide recognition.**



A problem cannot be solved with the same kind of thinking that created it.

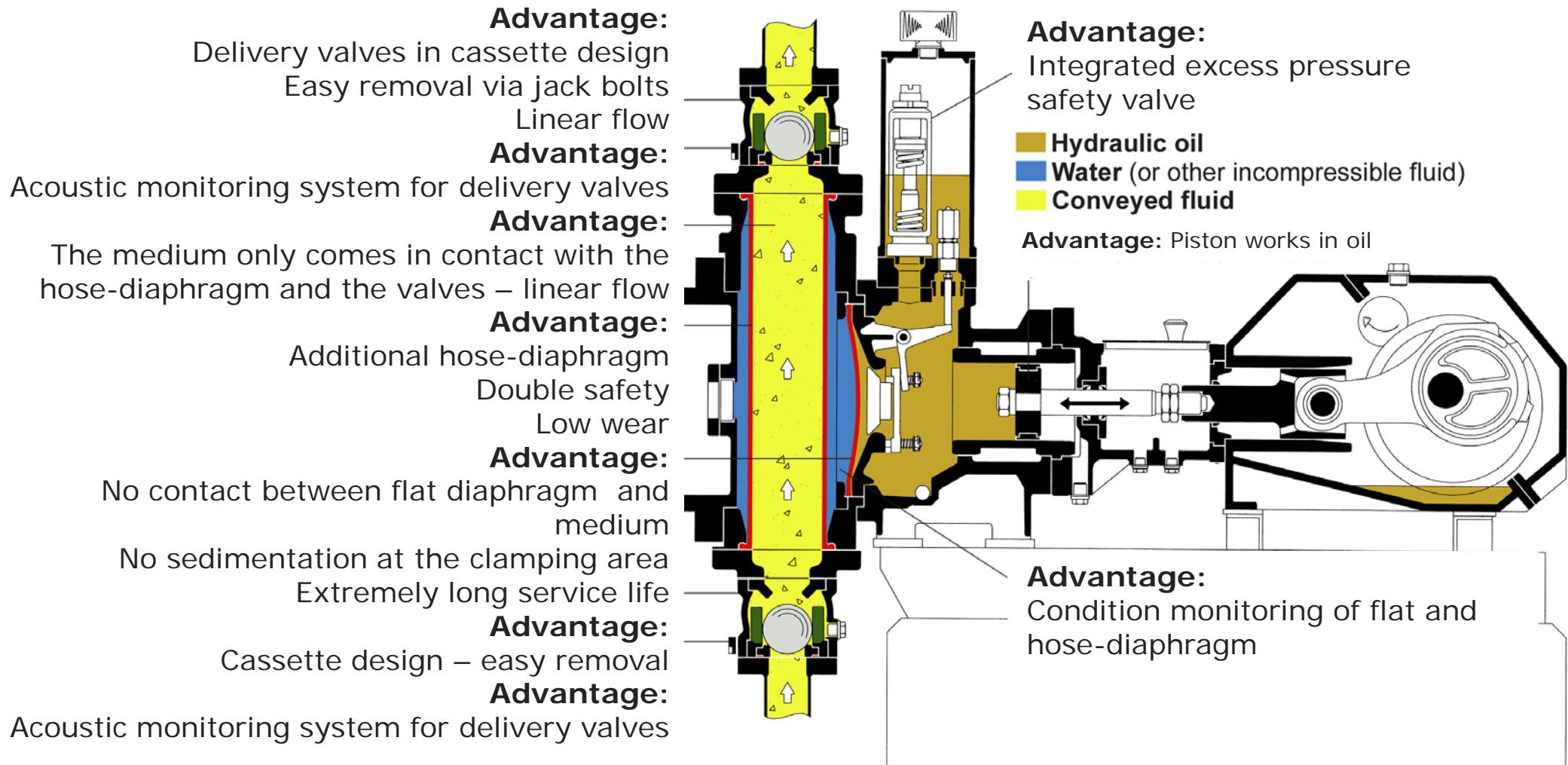
# Evolution of FELUWA MULTISAFE® Pumps

In 1972 FELUWA developed the Hose Diaphragm Piston Pump





# Advantages of FELUWA Hose Diaphragm Piston Pumps

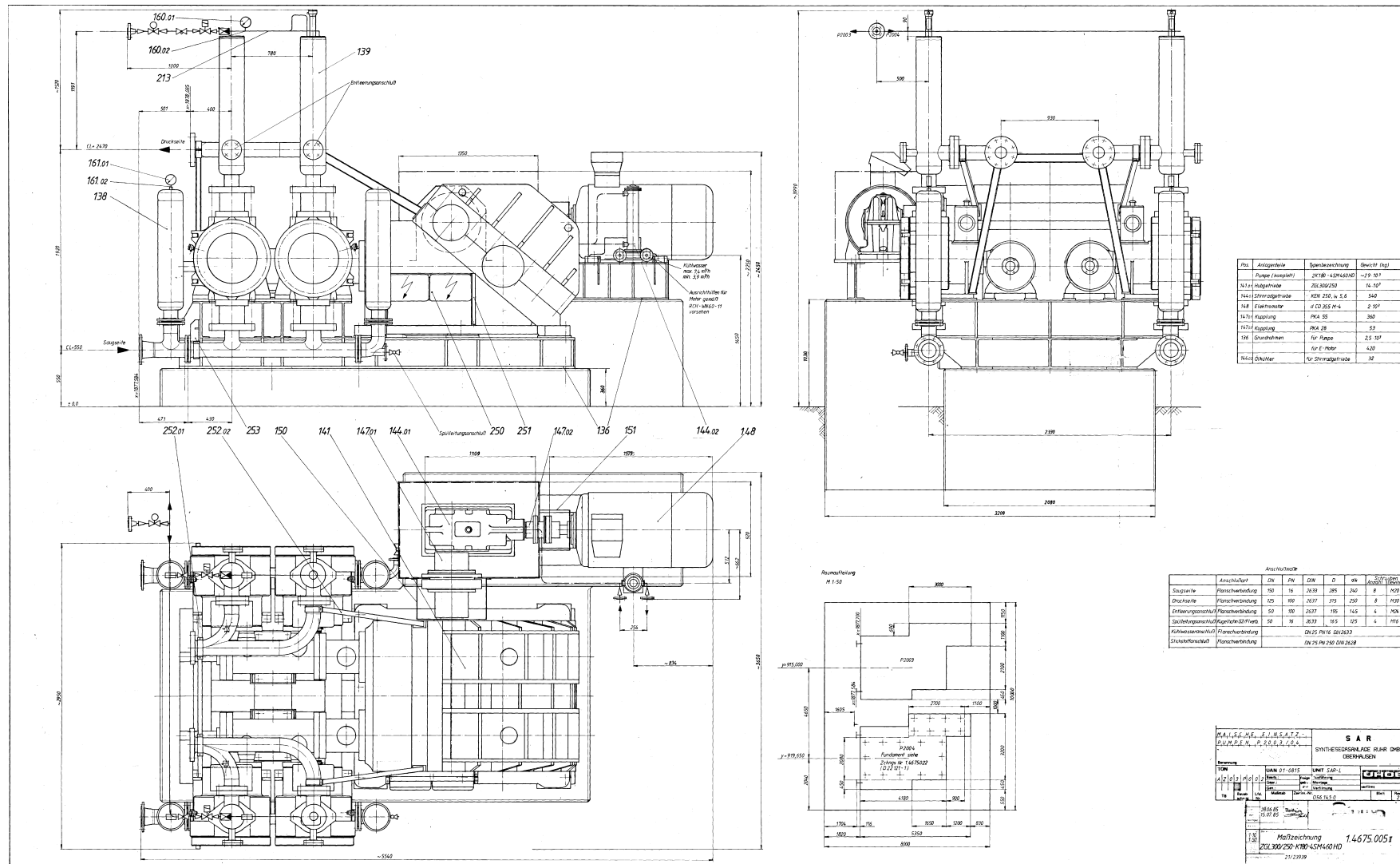


**1985:**

**Development, production, delivery and  
commissioning of a larger gasifier feeding pump  
(diaphragm piston pump) for Ruhrchemie/Germany**

# Arrangement Drawing Ruhrchemie

ZGL 300/250 – 2K180 – 4 SM 460 HD; 60 m³/h; 65 bar



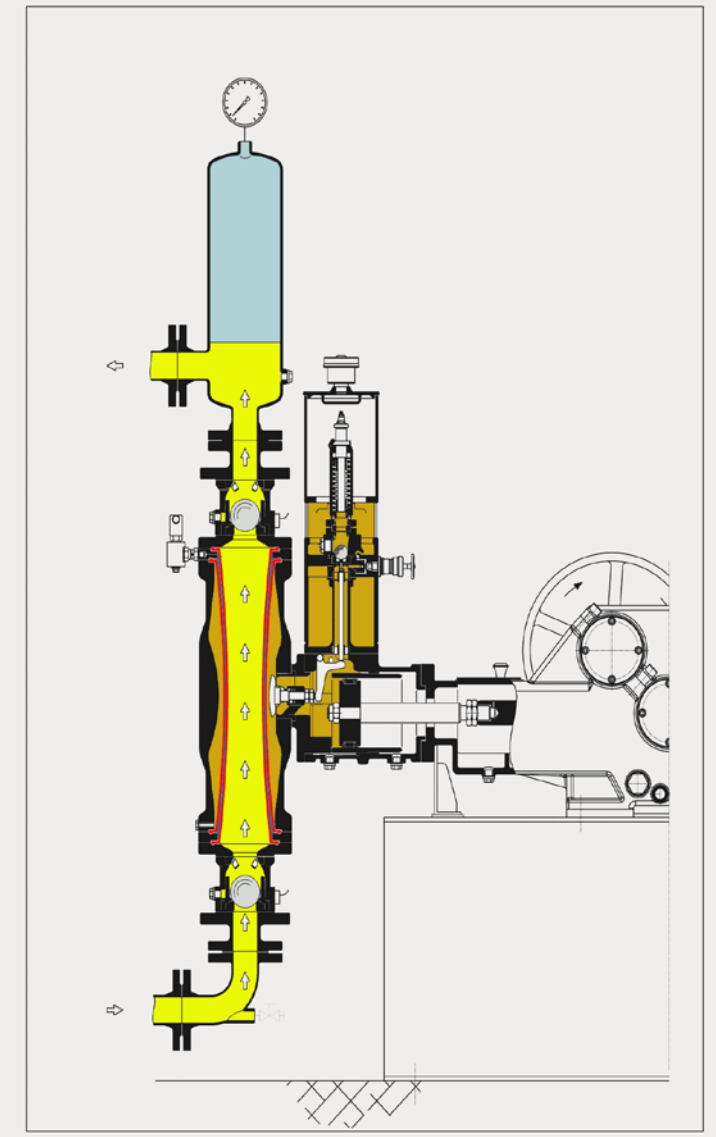
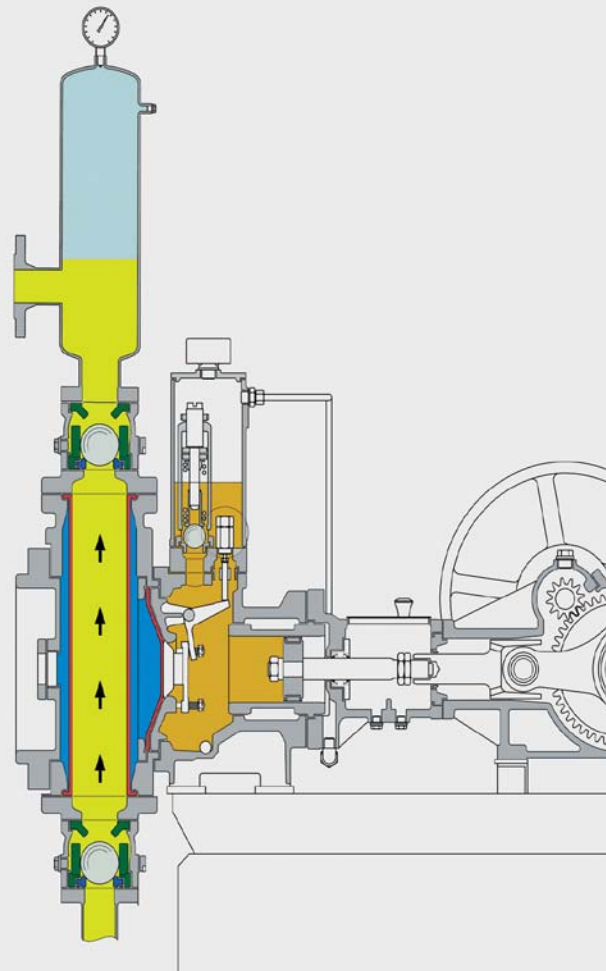
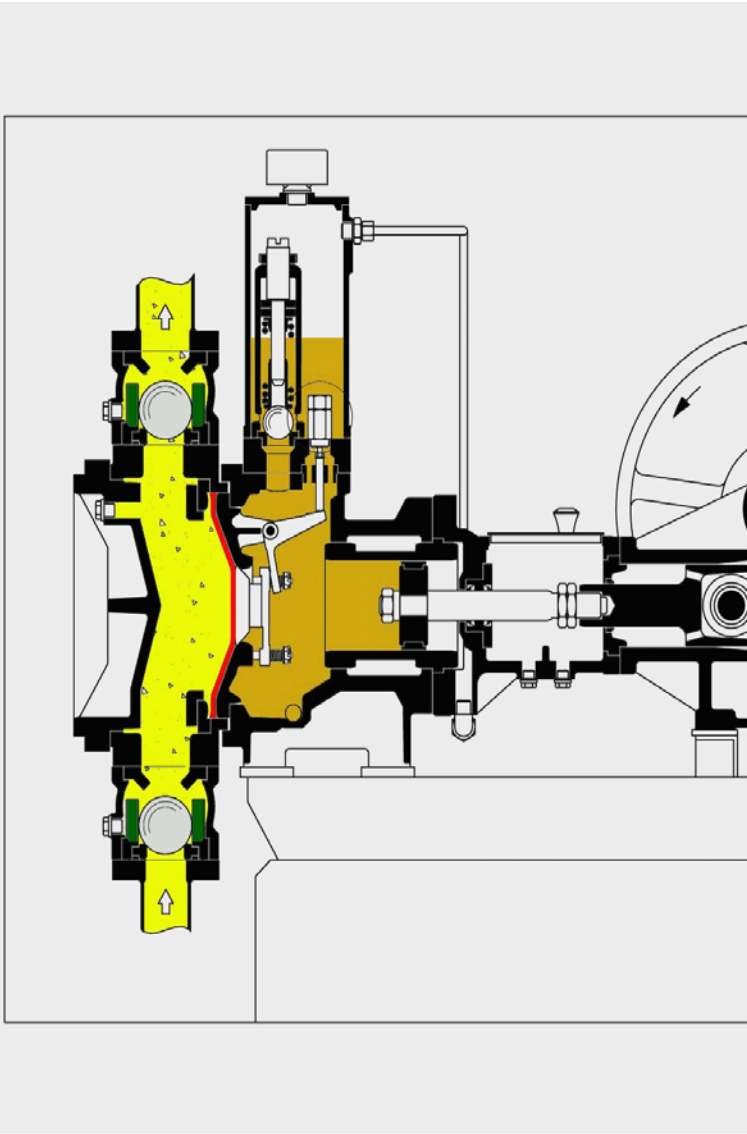
- *2001:*

In line with the continuous further development, enhancement of the technical and commercial value and improvement of plant availability, the 3<sup>rd</sup> generation of hermetically sealed oscillating displacement pumps was developed: the FELUWA MULTISAFE<sup>®</sup> double hose-diaphragm piston pump.

**The double hose-diaphragms of MULTISAFE<sup>®</sup> double hose-diaphragm pumps are no longer regarded as typical wearing part.**

# Evolution of FELUWA MULTISAFE® Pump

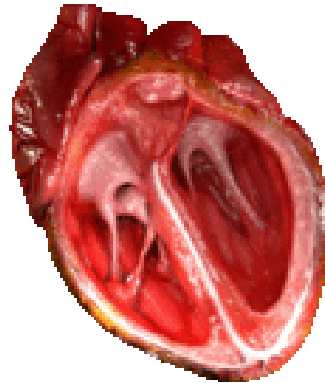
In 2002 FELUWA developed the unique MULTISAFE® Double-Hose-Diaphragm Pump



# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



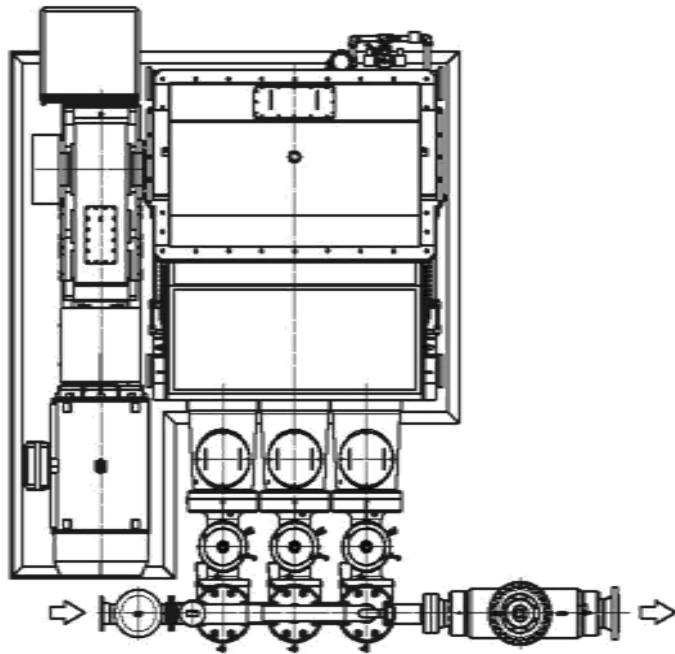
## Importance of gasifier slurry feeding pumps



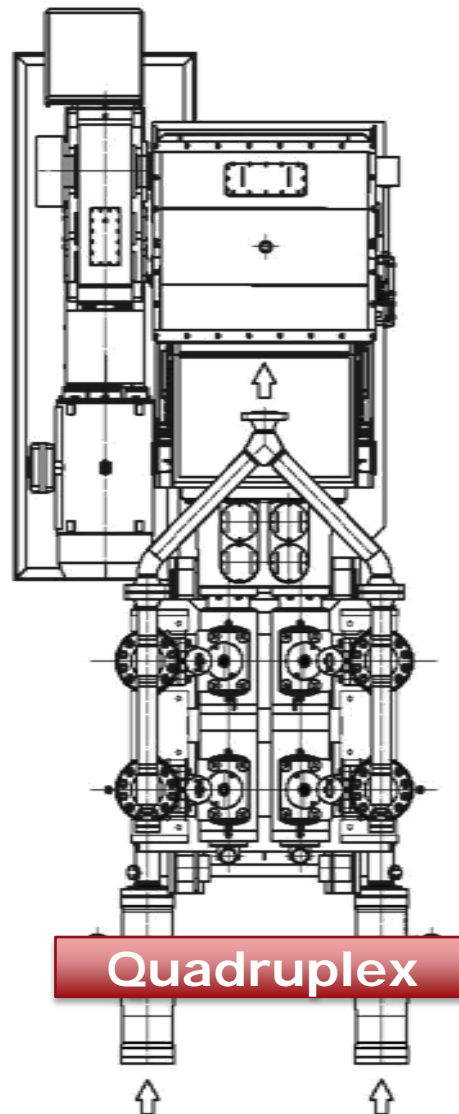
**The heart is the blood pump of a human body.  
And the gasifier slurry feeding pumps are the  
hearts of gasification plants**

# Double Hose-Diaphragm Pumps

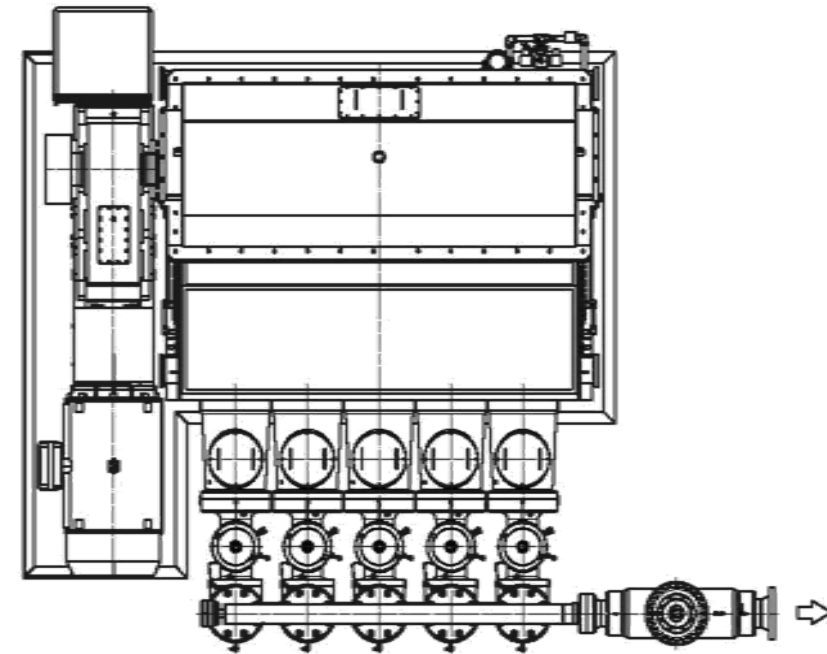
- Gear Types and Pump Designs -



**Triplex**



**Quadruplex**



**Quintuplex**

## *2001 - 2012:*

- 2001 start successful cooperation with ENCORE/China
- Continuous enhancement of the check valves, which nowadays achieve operating times of more than 16,000 hours.
- In-house production of valve balls.
- Development of TopEntry easy repair valves (upward instead of downward removal of valve trim) with FELUWA Quick Change device.
- Development of Quintuplex MULTISAFE® double hose-diaphragm pump, with a flow rate of **1000** m<sup>3</sup>/h.



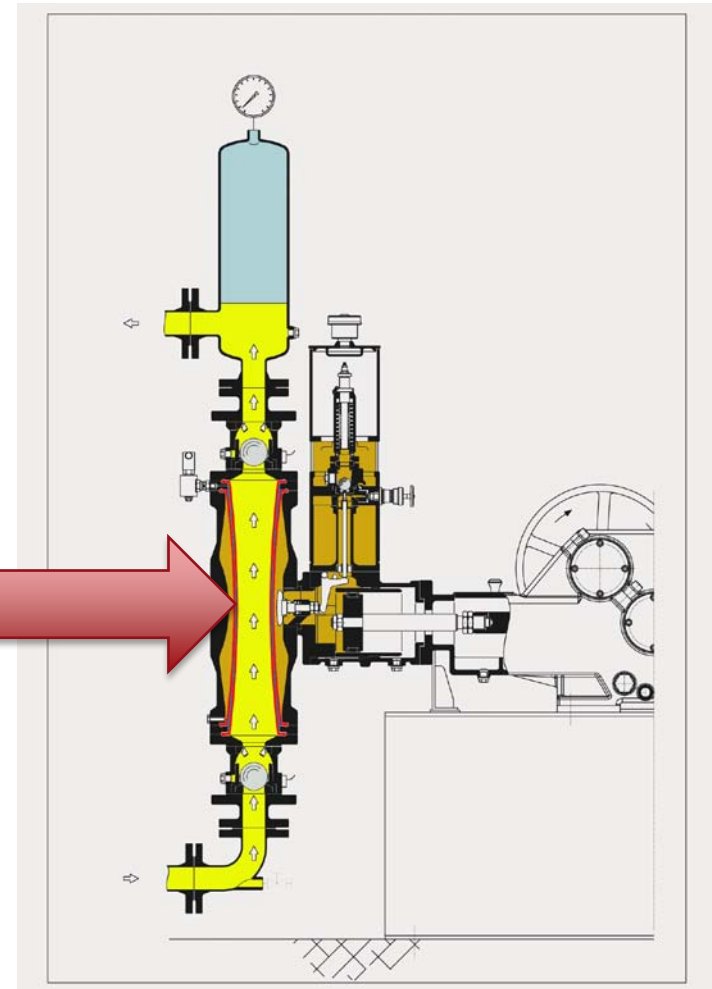
# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## Importance of gasifier slurry feeding pumps

### Safety

- Safety 1 (double hose)



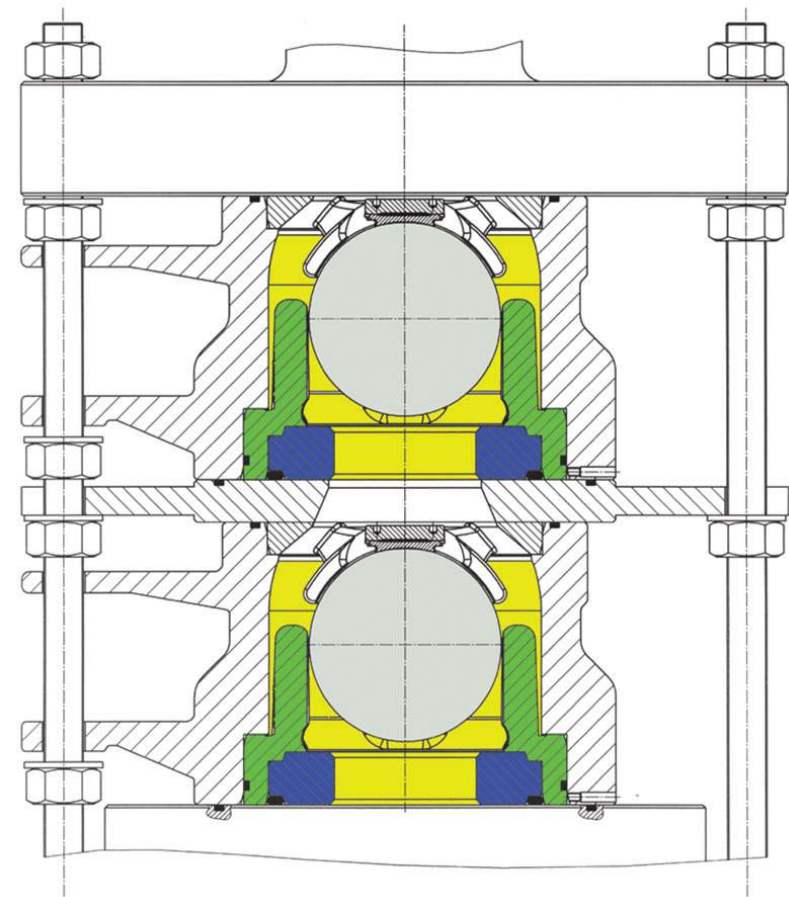
# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## Importance of gasifier slurry feeding pumps

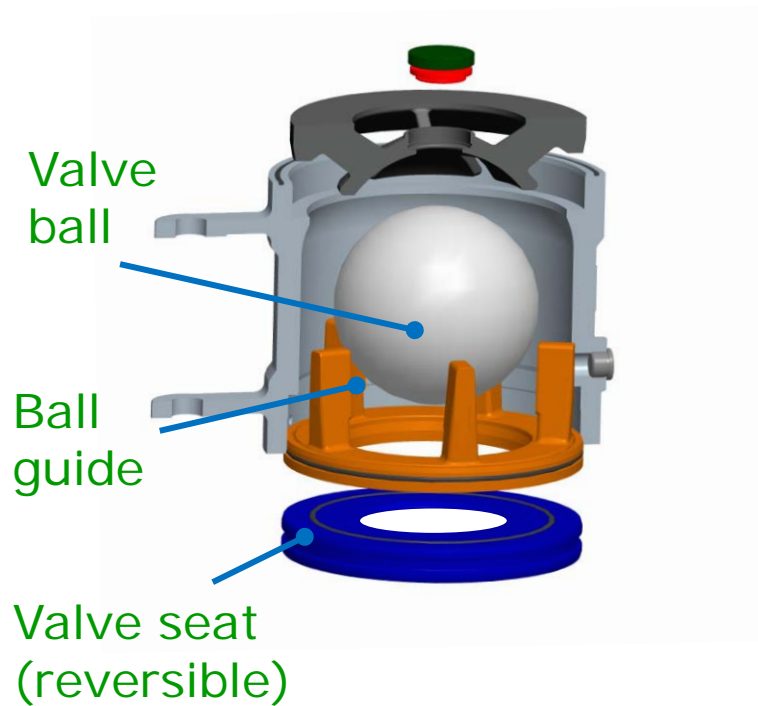
### Safety 2 (double valve)

- Double ball valve (closed) with metal sealing
- Elastomer upper ball retainer
- Swivel-type design

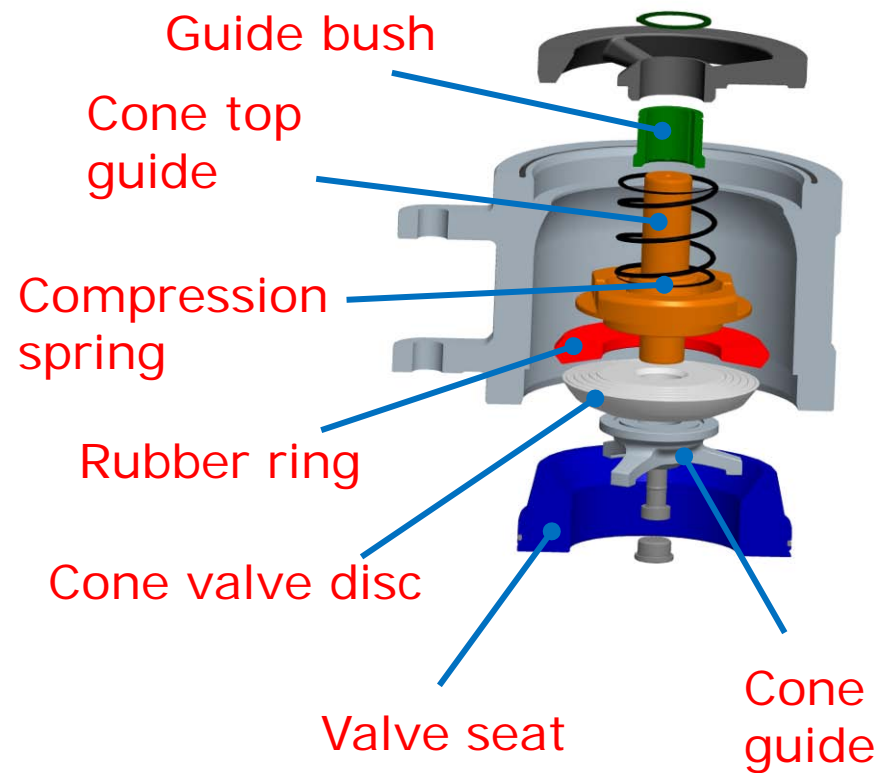


# Ball Valve vs. Cone Valve

## Ball Valve



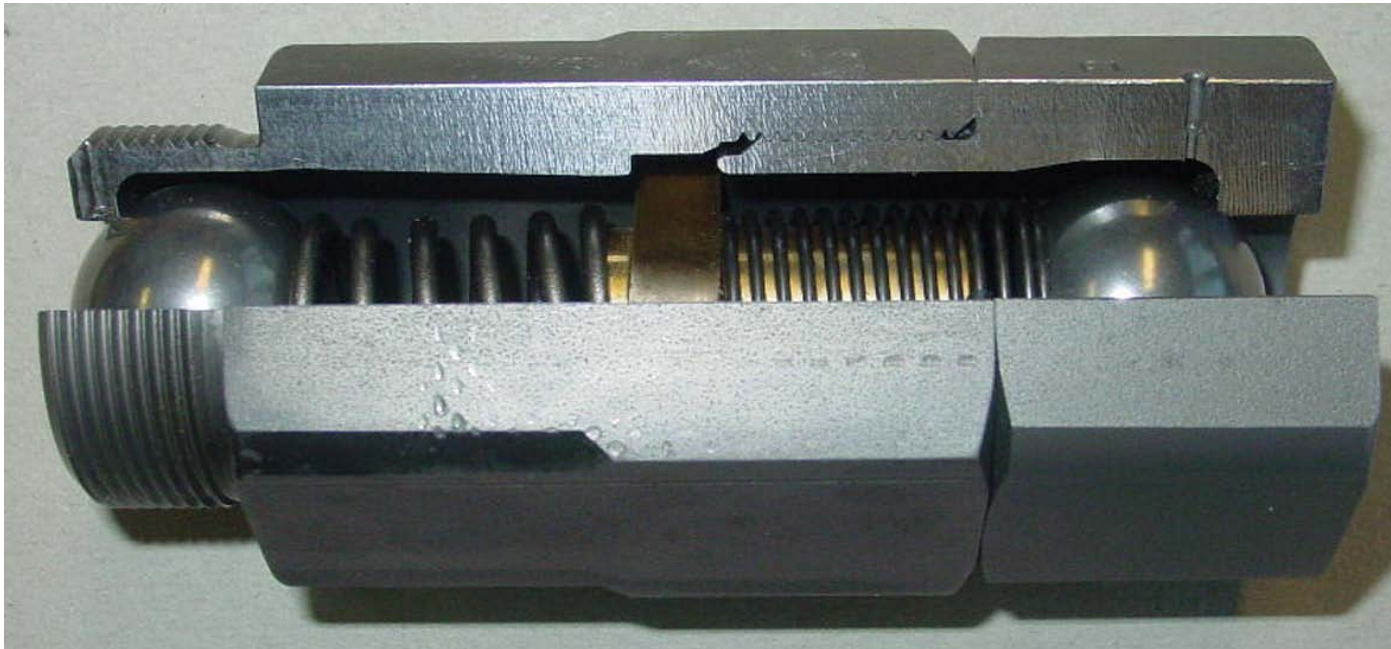
## Cone Valve



# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump (Mechanically locked vacuum leakage make up valve)



## Safety 3 (Leackage Compensating valve)



**Unique an reliable FELUWA Leakage Compensating Valve  
Section**

# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## 2. Durability

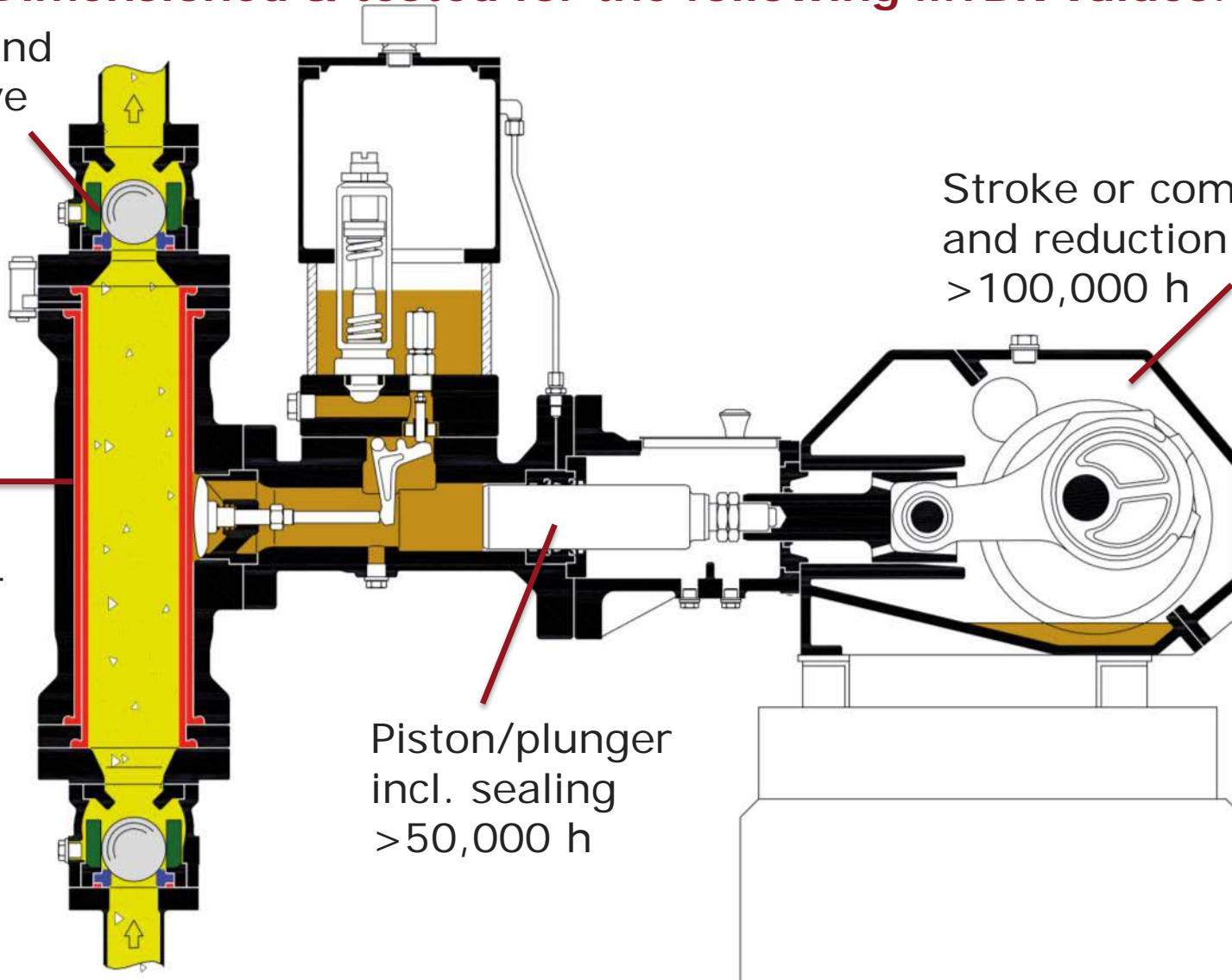
Dimensioned & tested for the following MTBR values:

Discharge and  
suction valve  
> 16,000 h

Double hose-  
diaphragm  
> 30.000 h

Stroke or combined stroke  
and reduction gear  
> 100,000 h

Piston/plunger  
incl. sealing  
> 50,000 h





# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## 3. Availability/Reliability

### Testimonial of FELUWA pump

There are 20 sets FELUWA hose diaphragm pumps in our company:

#### High pressure coal slurry pump:

Type No.	Pressure	Flow	Quantity
ZGL300/250-2K190-4SM460HD	100bar	48 m³/h	2 sets
ZGL200/200-2K150-4SM460HD	100bar	24 m³/h	2 sets
DG400/400-2K180-4SM760HD	105bar	73 m³/h	1 set
ZGL300/250-2K180-4SM460HD	105bar	48 m³/h	1 set
TGK400/400-K200-DS230HD	106bar	90.5 m³/h	4 sets
ZGL350/250-2K200-4DS100HD	94bar	80 m³/h	6 sets

#### Low pressure coal slurry pump:

Type No.	Pressure	Flow	Quantity
ZGL60/130-2K150-4SM460	16bar	47 m³/h	3 sets
ZGL60/130-2K200-4SM460	16bar	64 m³/h	1 sets

Since commissioning, the operation of FELUWA pumps is very stable and reliable. The installation and maintenance are easy and simple. The performance of FELUWA pump meets the requirements of our production process. The life time of check valves and hose diaphragms are over two years.

We are willing to recommend FELUWA pump to other end users.

Hualu Hengsheng Chemical Industry Co., Ltd.  
June 30, 2017

### 使用情况说明书

山东华鲁恒升化工股份有限公司, 现有德国 feluwa 软管隔膜泵共 20 台。

#### 高压煤浆泵型号:

泵型号	压力	流量	数量
ZGL300/250-2K190-4SM460HD	100bar	48m³/h	2 台
ZGL200/200-2K150-4SM460HD	100bar	24m³/h	2 台
DG400/400-2K180-4SM760HD	105bar	73m³/h	1 台
ZGL300/250-2K180-4SM460HD	105bar	48m³/h	1 台
TGK400/400-K200-DS230HD	106bar	90.5m³/h	4 台
ZGL350/250-2K200-4DS100HD	94bar	80m³/h	6 台

#### 低压煤浆泵型号:

泵型号	压力	流量	数量
ZGL60/130-2K150-4SM460	16bar	47m³/h	3 台
ZGL60/130-2K200-4SM460	16bar	64m³/h	1 台

所有德国 feluwa 软管隔膜泵, 自投运以来, 各项性能指标完全满足工艺生产要求。该系列软管隔膜泵的使用寿命均达到两年以上, 维护方便, 操作简单, 设备运行稳定可靠。

特此证明

华鲁恒升化工股份有限公司

20170630



# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## 3. Availability/Reliability

**Eastman Chemical Company**

**Fine Tuning to Improve Availability and Reliability of Coal Based Gasification**

Gasification Technologies 2001  
San Francisco, California  
October 7-10, 2001

Written By  
Steve Hrivnak, Principal Mechanical Engineer

Presented By  
Nathan Mooock, Senior Chemical Engineer

**EASTMAN**  
The Chemistry of New Ideas

**1983 - 2001**

# Unique FELUWA MULTISAFE® Double Hose-Diaphragm Pump



## 3. Availability/Reliability

### Top 10 Shutdown Causes 1983 – 2000

Rank	Shutdown Cause	% of total
1	Feed Injector Failure	18.5%
2	Slurry Feed Pump	15.2%
3	Planned Switch	10.7%
4	Low Quench H2O Flow	6.7%
5	Low Slurry Flow	5.7%
6	Low level in Gasifier	4.7%
7	O2 Leak	4.0%
8	PSV failure	2.5%
9	Dip/Draft Tube	2.0%
10	DCS - PLC failure	2.0%





***2003:***

**Development of the FELUWA online diagnostic system (FVPMS  
= FELUWA Valve Performance Monitoring System)**

***2004:***

**FELUWA obtains the ATP award for their Valve Performance  
Monitoring System**

**2004:**

**In line with the continuous further development, enhancement of the technical and commercial value and improvement of plant availability, the 3rd generation of hermetically sealed oscillating displacement pumps was developed: the FELUWA MULTISAFE® double hose-diaphragm piston pump.**

- The MULTISAFE® double hose-diaphragms achieve operation times of several years in continuous operation.**
- The double hose-diaphragms of MULTISAFE® double hose-diaphragm pumps are no longer regarded as typical wearing part.**

**Upflow: Ball Test 36spm, with Special Ball Guide,  
Modified Ball Retainer (s=3.5mm)  
0.2 mm gap between ball and ball guide**



Valve seats with metal sealing



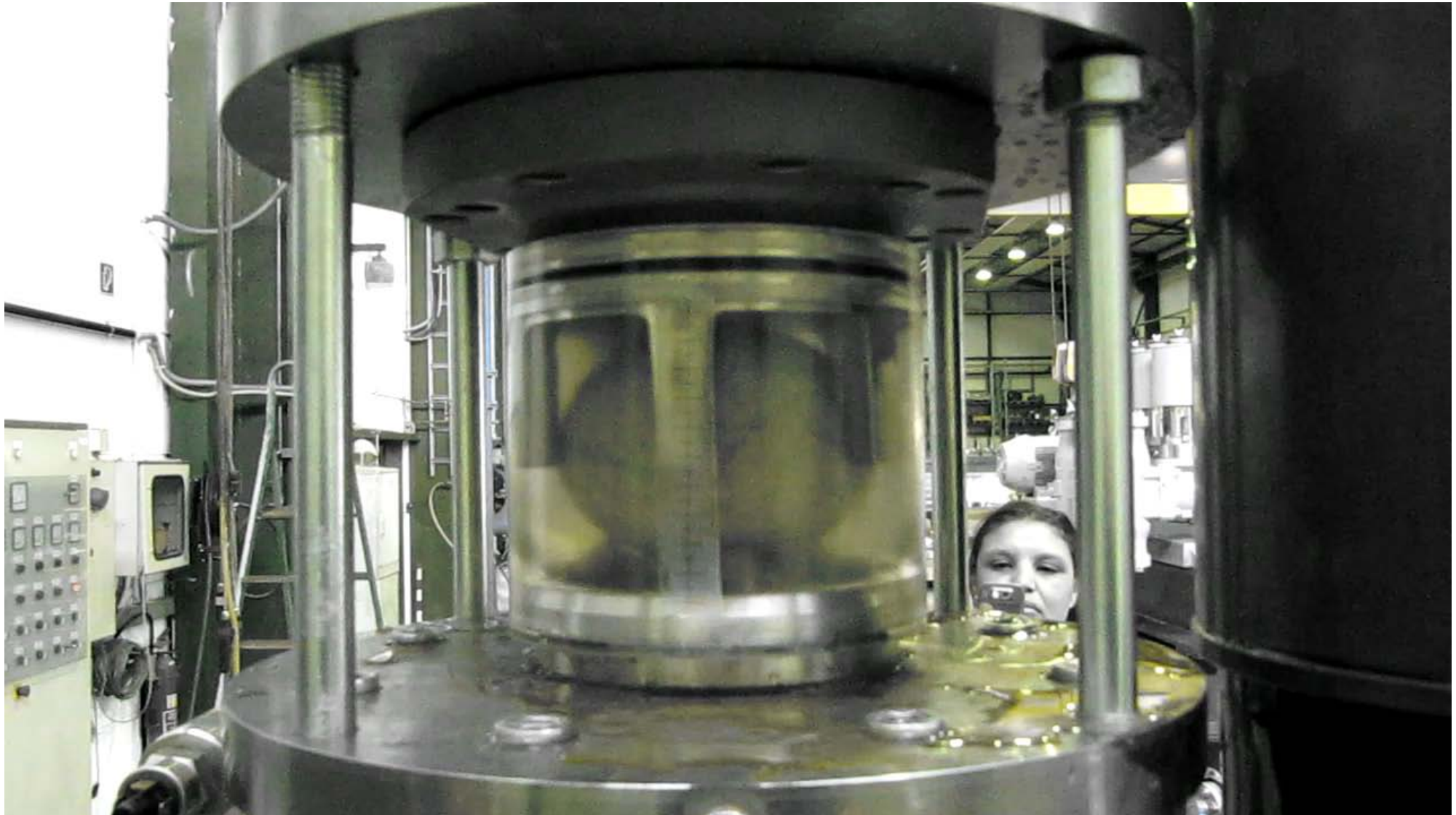
High Speed Camera 10s = 1s

# Downflow: Ball Valve Test nH 36/minute Without Ball Guide





# Downflow: Ball Valve Test 36spm with Ball Guide (2/10 mm gap between ball and ball guide)



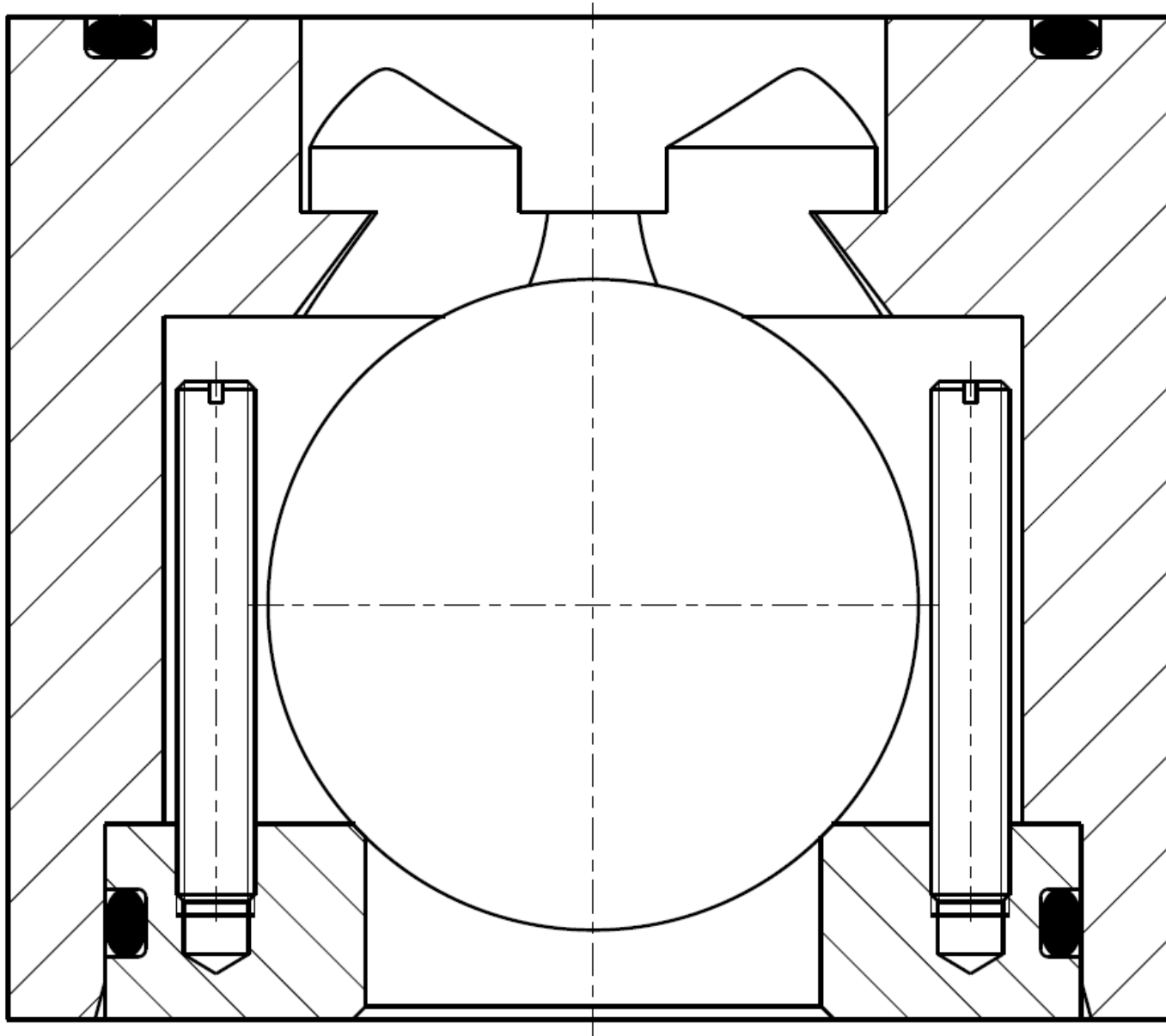
# Unique FELUWA wafer type Ball Valve



# Ball Valve

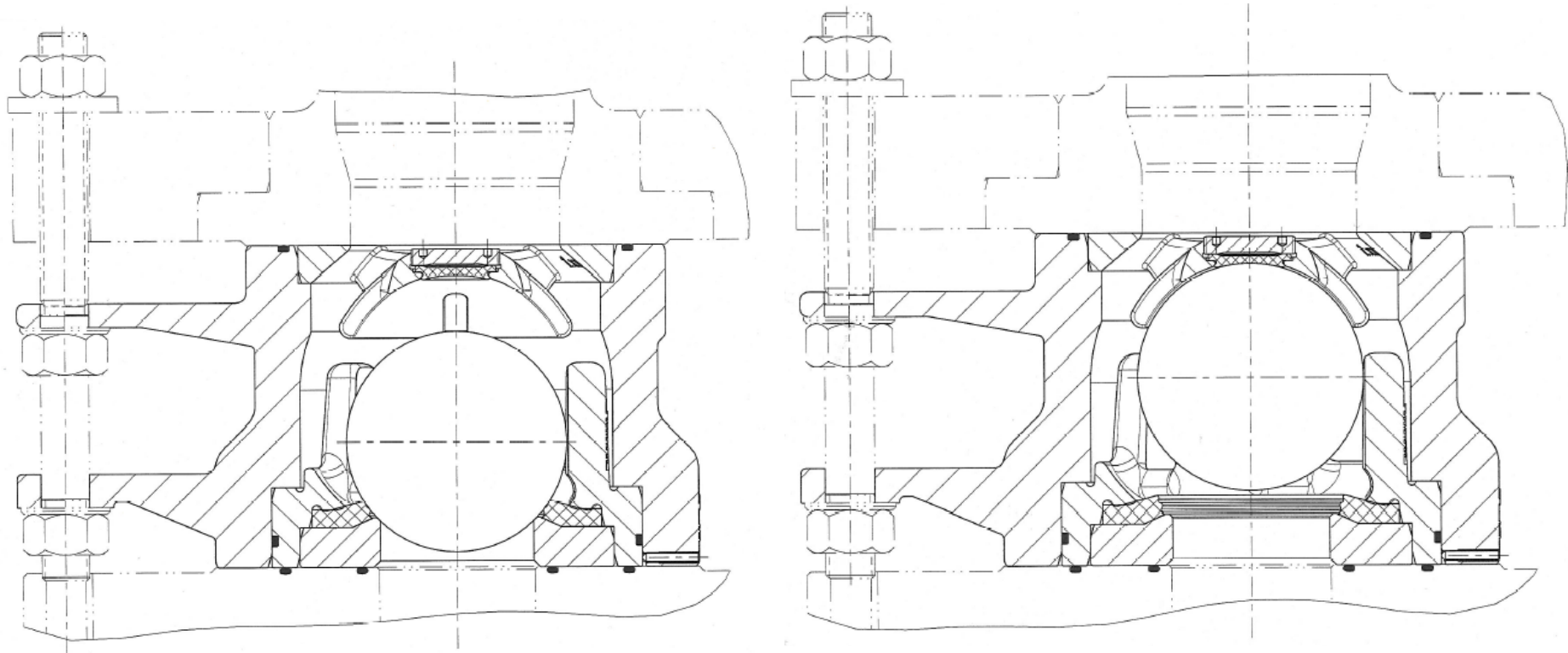
Upflow optimisation

# Valve 50 Triplex Pump





# FELUWA "Ruhrchemie" Ball Valve 137 with Soft Sealing Including Calotte Stroke Limiter

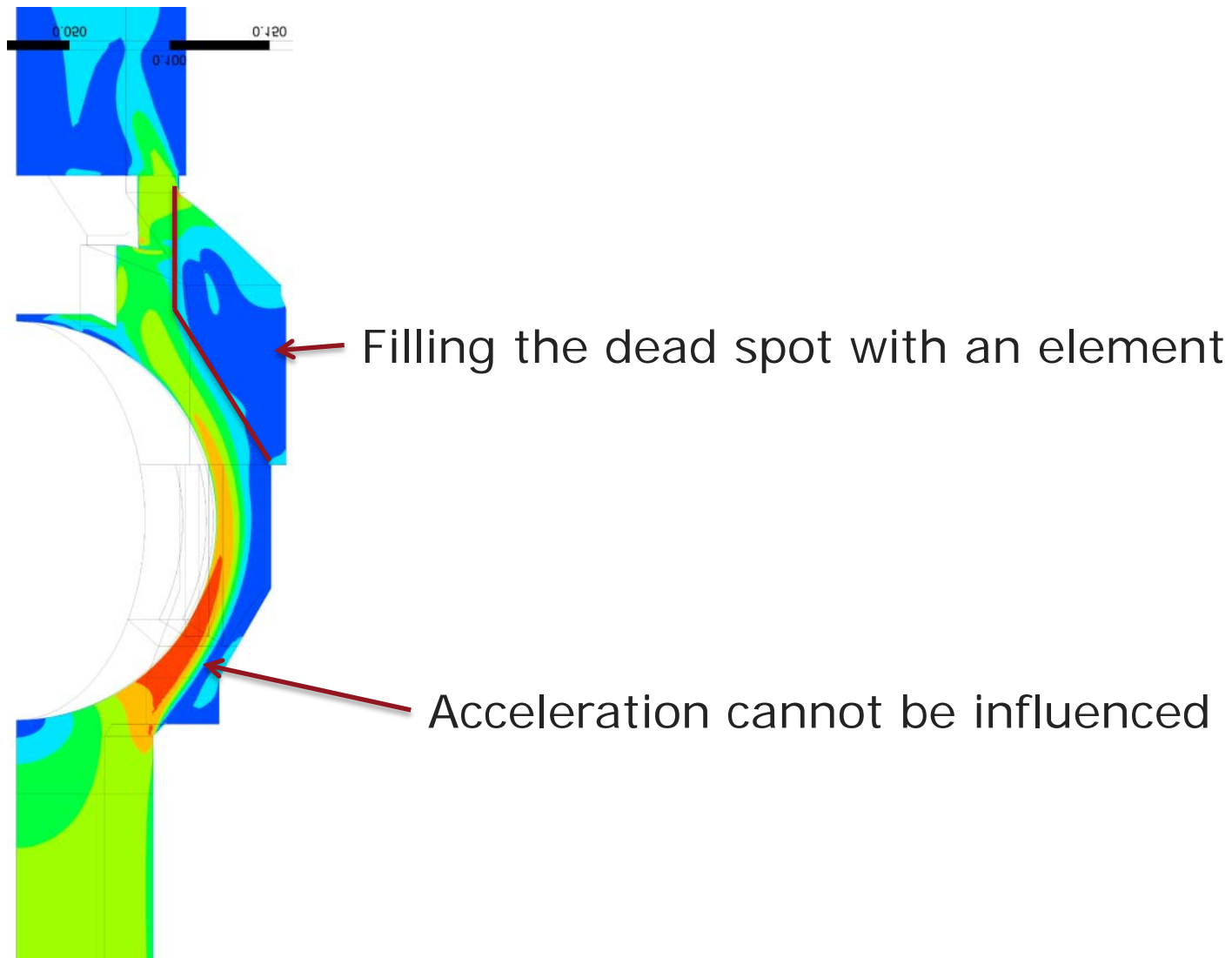


ZGL 300/250 – 2K180 – 4 SM 460 HD; 60 m<sup>3</sup>/h; 65 bar



- Previous valve was not operating satisfactorily
- Simulation shows forces against the flow
  - Strong acceleration behind valve seat
  - Delay/stagnation point at ball retainer
- Existing but low lateral forces

# Optimisation – an additional component

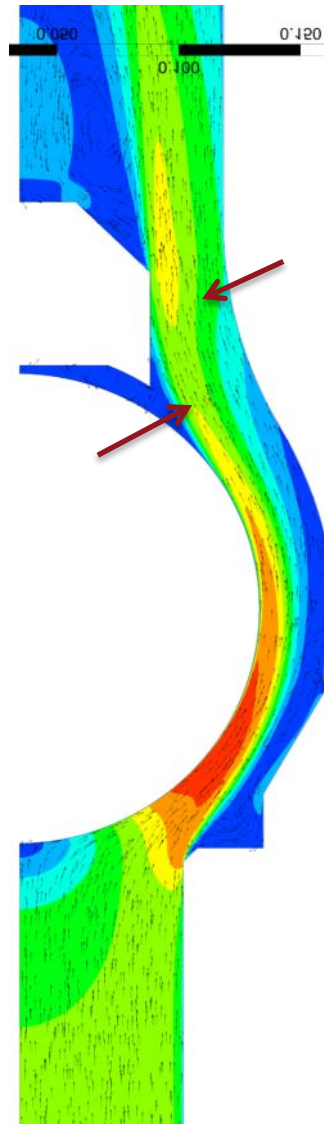


# Variants 2D - Velocity

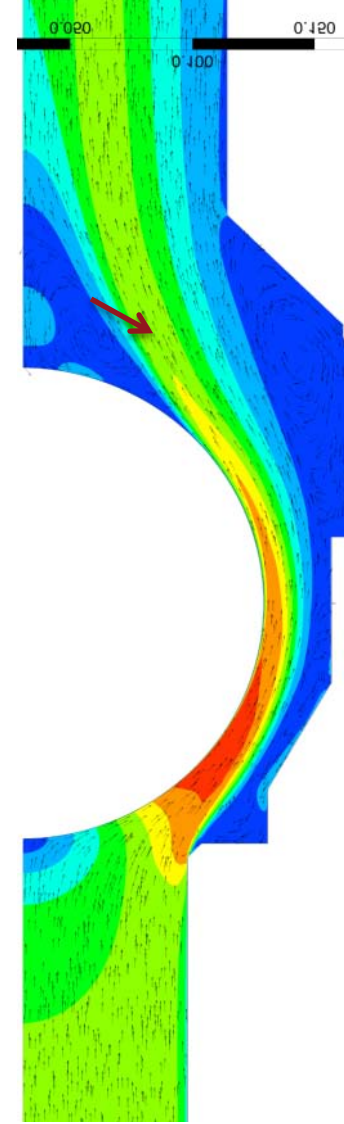
Old



With flow director



Without  
ball retainer



# FELUWA – a Vision Became a Great Success



## Success story coal gasification in China

- 108 projects were successfully completed
- 367 high pressure pumps (PN 90 bar) and 69 low pressure pumps (PN 16) are successfully in operation in China.
- Total flow rate: 34,147 m<sup>3</sup>/h coal slurry
- There are 2,934 individual of valves.
- If all pumps are being operated, the valves are carrying out 1,956 closing cycles per second ! Respectively 117,360 cycles per minute!!
- The high pressure pumps provide the gasifiers with a total of 28,185 m<sup>3</sup>/h highly viscous coal slurry.
- They produce  $(28,185 \times 0.62 \times 2500) = 43,686,750$  Nm<sup>3</sup> syngas/h.



# FELUWA Pumpen GmbH

## Quality – Made in Germany



Real Estate: 103,241 m<sup>2</sup>    Building Area: 8,715 m<sup>2</sup>

**Many thanks indeed for your attention and your interest in our products.**