

# ***Larsen & Toubro Limited e-Engineering Solutions***

## **Engineering Services Outsourcing- Fluid Handling Systems**

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## Valves and Controls

- ◆ Gate
  - Solid / Flexible wedge
  - Parallel slide / Pressure seal
  - Through conduit –API 6D
  - Knife edge
- ✂ Globe
  - Rotary type
  - Pressure Balanced
- ◆ Check
  - Swing / Piston type
  - Tilting disc
  - Dual plate
  - Damper /Dashpot
- ◆ Ball
  - Floating type
  - Trunion mounted
- ◆ Butterfly
  - ✂ Standard / Single concentric
  - ✂ Double concentric
- ✂ Plug
- ✂ Diaphragm / Pinch
- ✂ Safety relief

## Valves for Special Application

- ✂ Cryogenic & Bellows seal
- ✂ NACE
- ✂ Mining
- ✂ Nuclear
- ✂ Slurry & Buried
- ✂ Hydrogen ,Steam & FE
- ✂ Hygienic

## Regulators

- ◆ Air
- ◆ Liquid or gas

## Actuator

- ◆ Diaphragm/ piston
- ◆ Pneumatic /Electrical /Hydraulic

## Pumps & Pressure Equipment

- ◆ Centrifugal pumps
- ◆ Compressors/Turbine

## Process Instruments

- ◆ Flow-meters / Level Indicators
- ◆ Pressure Transmitter

## Traditional Focus – Staff Augmentation

- ◆ Routine tasks
- ◆ Non-core activities
- ◆ Low skill levels
- ◆ Less control to service provider
- ◆ Hence less accountability w.r.t quality & outcome

## New Paradigm

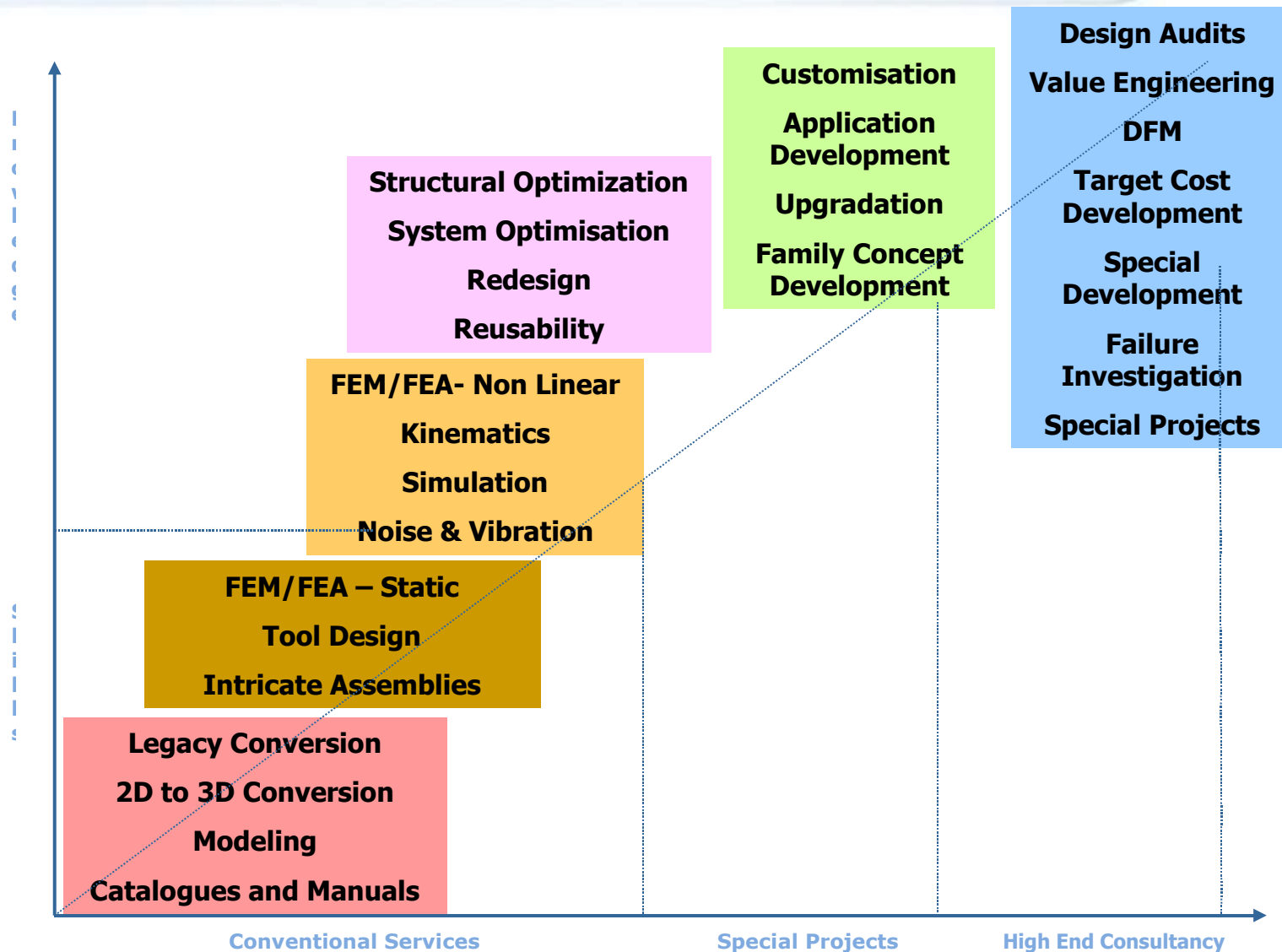
- ◆ Service provider gets more involved, higher level of trust, more control to service provider
- ◆ Engagement long enough to build deeper domain expertise
- ◆ Leverage expertise for subsequent assignments
- ◆ Highly skilled work force is required

## Wide spectrum available:

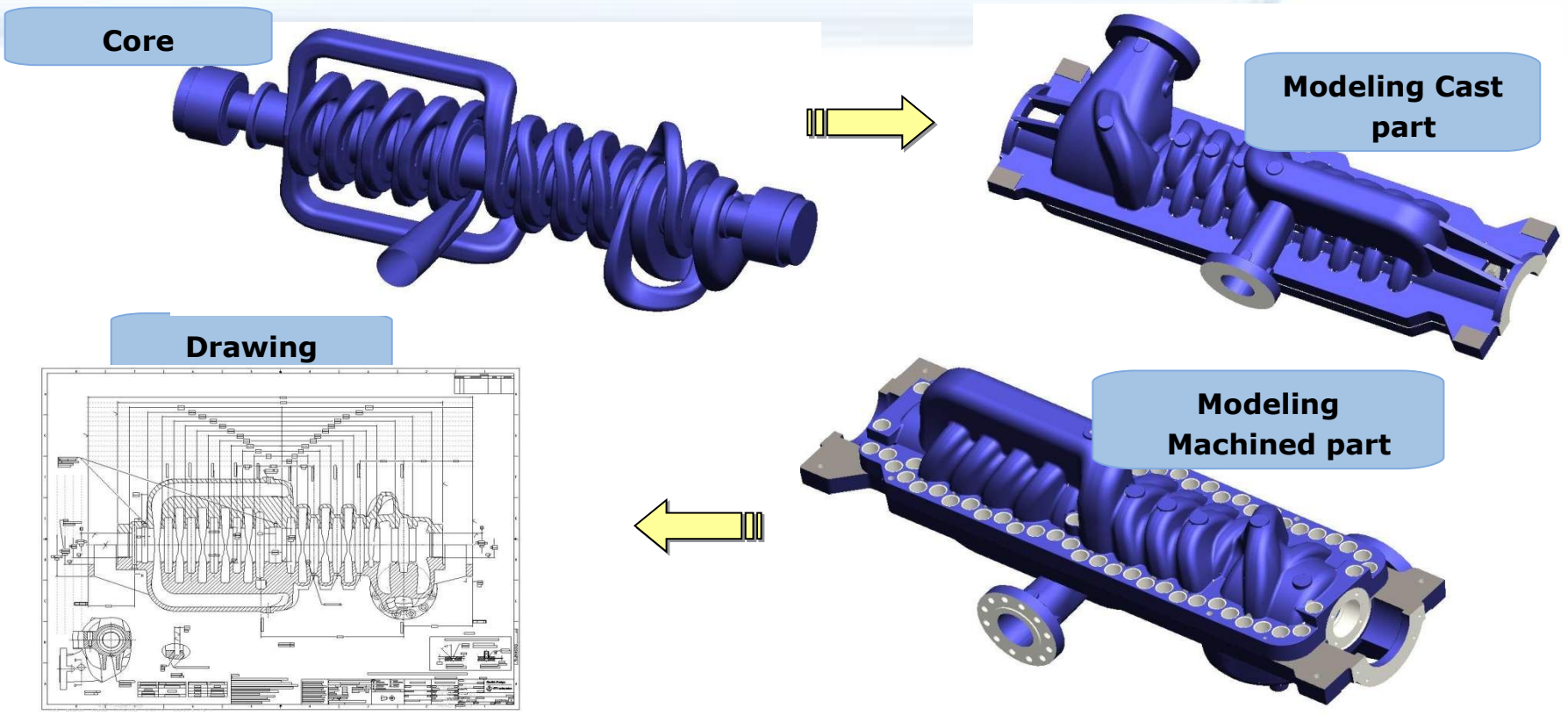
- 2D to 3D conversion
- Legacy Data conversion
- Technical Publishing
- Proposal engineering
- ECN/ ECR
- Warranty analysis
- Procurement Support

- Cost Reduction (Target)
- New Product Introduction in a different market
- Value Engineering
- BOM Rationalization
- SKU Reduction
- Process re-engineering
- Part Count Reduction
- Carbon Footprint Management

# Value Chain of Engineering Services

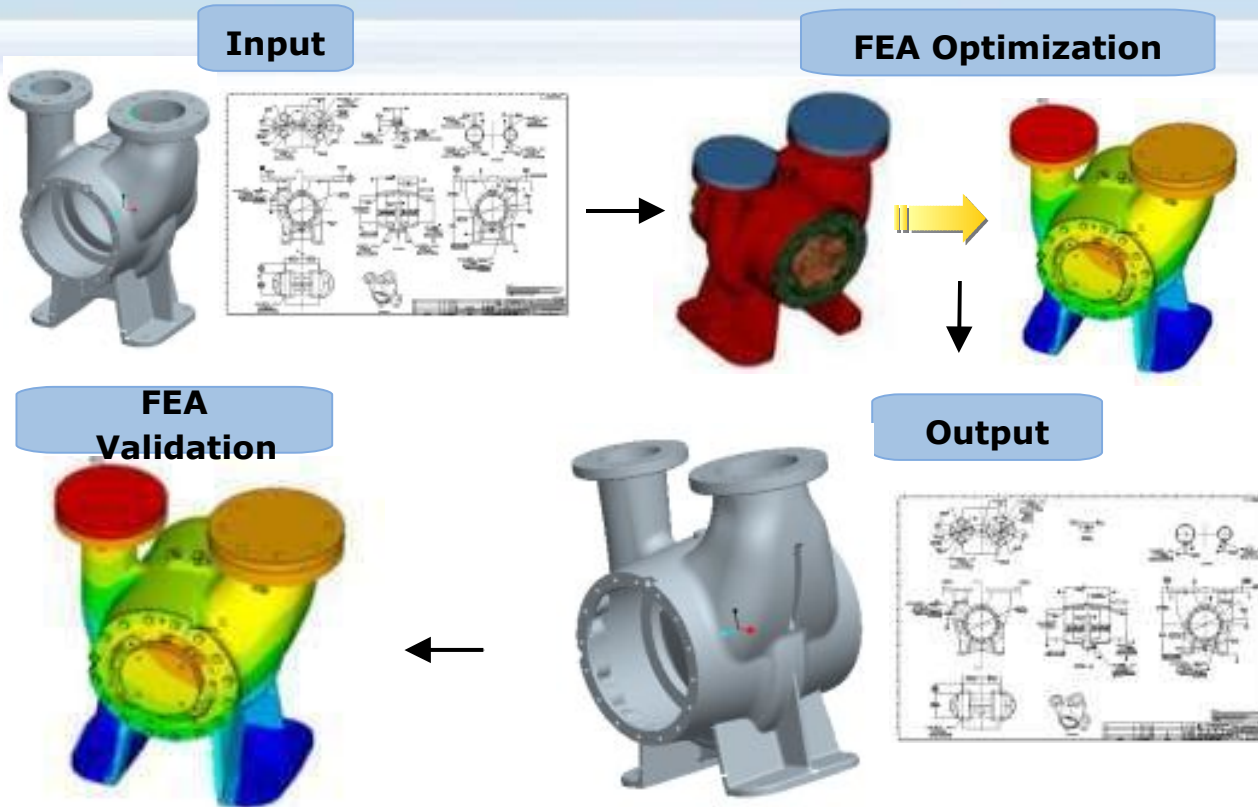


# Castings Modeling & Core Design



<b>Scope :</b>	Modeling of Core, Cast and Machined parts and Create Mfg drawings
<b>Input :</b>	2D Drawings in PDF
<b>Deliverables :</b>	3D Models of Core, Casting, Manufacturing Drawings for Casting & Machining
<b>Highlights :</b>	Models are generated using ITT modeling technique. i.e. Skeleton -> core -> cast -> machines. This is done keeping all the geometry parametric

# Weight Reduction Project



## Execution Methodology

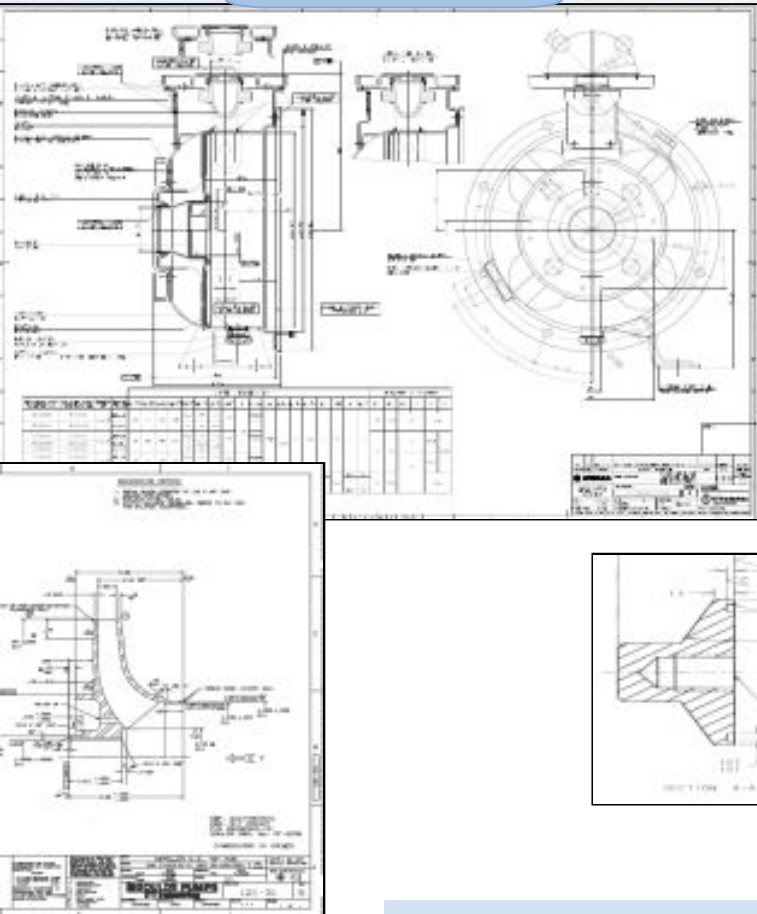
- Input Study & Requirement analysis
- Preparation of FEA models for optimization analysis
- FEA optimization Analysis
- Design changes finalization & optimization of CAD models
- FEA Validation analysis
- Modification in CAD models for process allowances & any other changes if required
- FEA revalidation analysis
- Updating manufacturing drawings for casting & machining
- Results delivered

<b>Scope :</b>	Redesign of existing volute & Cover plate to achieve minimum 20% weight reduction.
<b>Input :</b>	3-D Part Models, Material Properties, Pressure Vessel Standards & load conditions.
<b>Deliverables:</b>	Optimized 3D models & drawings and FEA validation reports.
<b>Challenges :</b>	Complex surface & skeleton modeling and critical modifications for weight reduction. <ul style="list-style-type: none"> <li>•High quality mesh generation for the analysis requirement.</li> <li>•Analyzing the model with actual assembly conditions.</li> </ul>

<b>VALUE ADDITION</b>
<ul style="list-style-type: none"> <li>✓ Cost reduction</li> <li>✓ Weight reduction</li> <li>✓ Simplified &amp; easily modifiable models</li> </ul>

# ANSI/ NSF CERTIFICATION

## Input-PDF files



## Output

RATIO CALCULATION : 9A-SH ASSEMBLY			
Description	TOTAL WETTED AREA (mm <sup>2</sup> ) (WETTED AREA X QTY)	Total Liquid Volume (mm <sup>3</sup> )	RATIO = (Total wetted surface area / Total liquid Volume inside Circulator)
13K217 IMPELLER STUD	0.00	1037670.50	0.000
4L458 IMPELLER WASHER	2447.98	1037670.50	0.002
4K517 SPRING RETAIN	3057.85	1037670.50	0.003
4L473 SHAFT SLEEVE	5423.88	1037670.50	0.005
1L465 SEAL HSG (1X2)	50498.70	1037670.50	0.049
1L450 CASING (1X2-6)	92067.76	1037670.50	0.089
4K555 IMPELLER KEY	0.00	1037670.50	0.000
IMP. PN			
150783407	118818.77	1037670.50	0.113
Description			
5K307 O-RING VIT	0.00	1037670.50	0.000
5L42 O-RING VIT	0.00	1037670.50	0.000
10K27 SEAL ASSY	3710.32	1037670.50	0.004
5K320 O-RING (SQUARE CUT)	0.00	1037670.50	0.000
<b>TOTAL</b>	<b>274025.26</b>	<b>1037670.50</b>	<b>0.264</b>

### Scope:

Calculation of wetted area of various assemblies alongwith volume of liquid for RATIO calculation for NSF-61 Certification

### Input:

PDF drawings

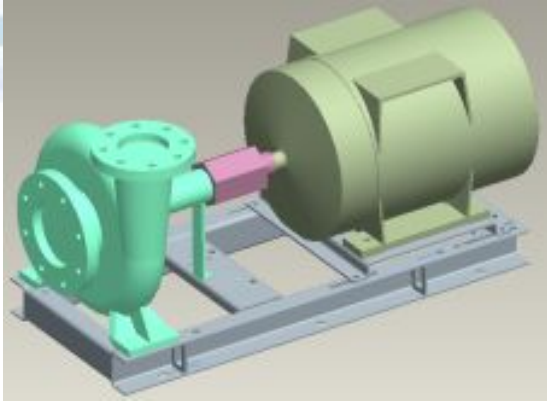
### Output:

Dully filled data as per required format

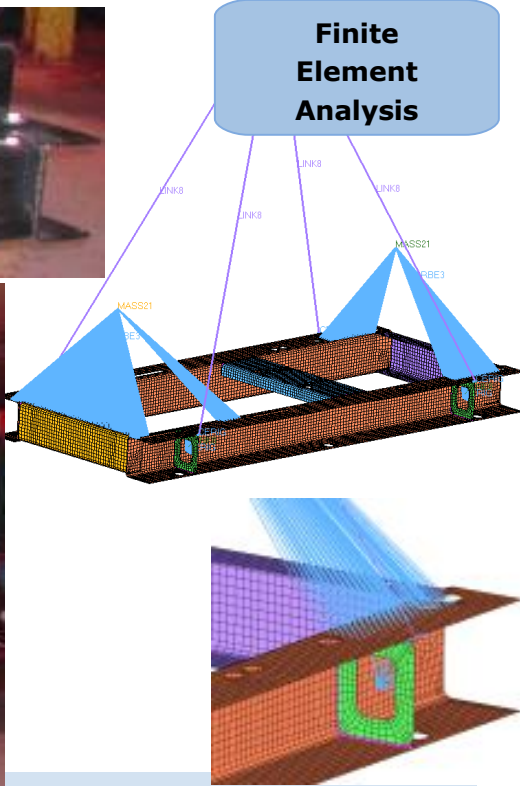
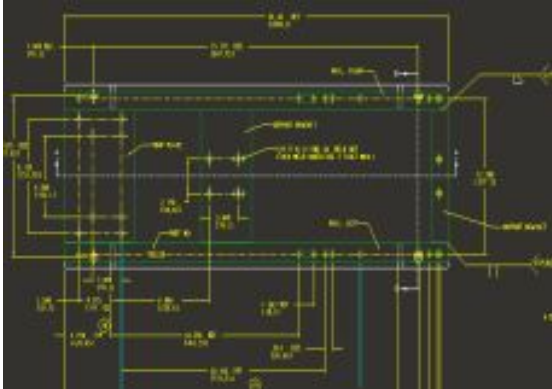
### Challenges:

Calculation of wetted area and hold up volume of each assembly in absence of CAD models.

# Develop common base for Pumps with Lugs



**Testing Results**



**Scope:**

Design of Lug (It Should be able to withstand the stresses occurring under extreme conditions of handling during the lifting & transportation)

**Input:**

Design Optimum position of the Lugs at the base plate

**Output:**

Pro/E files of Lug & Assembly

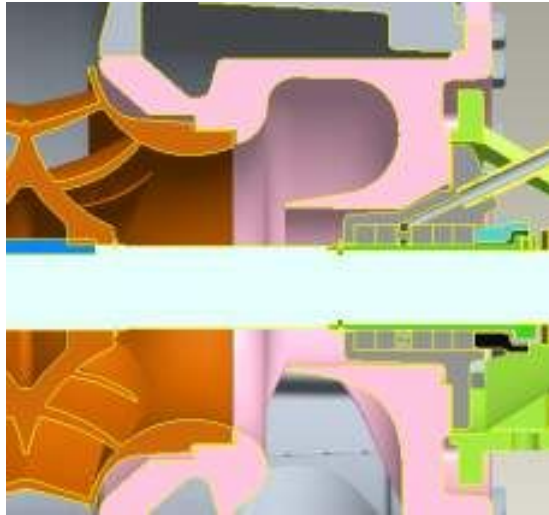
**Challenges:**

FEA Analysis results

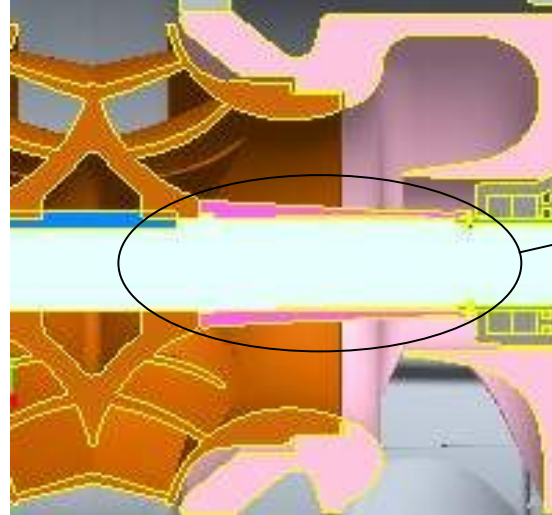
The base assembled with the heaviest motor & heaviest pump

When the 4 chains passing through the 4 lugs are hung from a single hook point

Existing Design without Sleeve



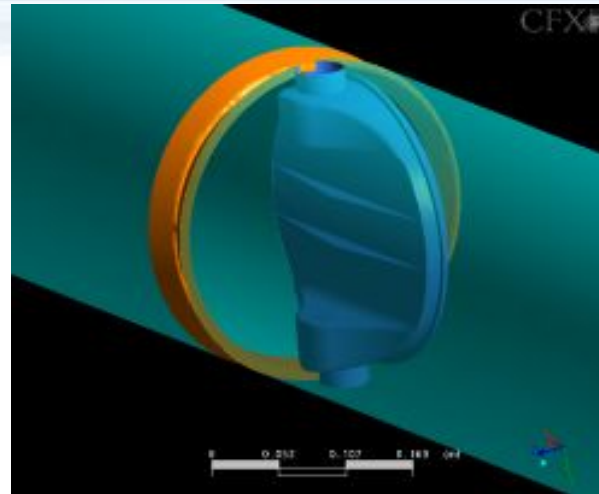
Modified Design with Sleeve

**Concept :**

Existing shaft design (SS316) is replaced by Shaft with AISI 1045 with intermediate SS316 Sleeves so that the modified design can be still used for corrosive applications.

**Achievement :**

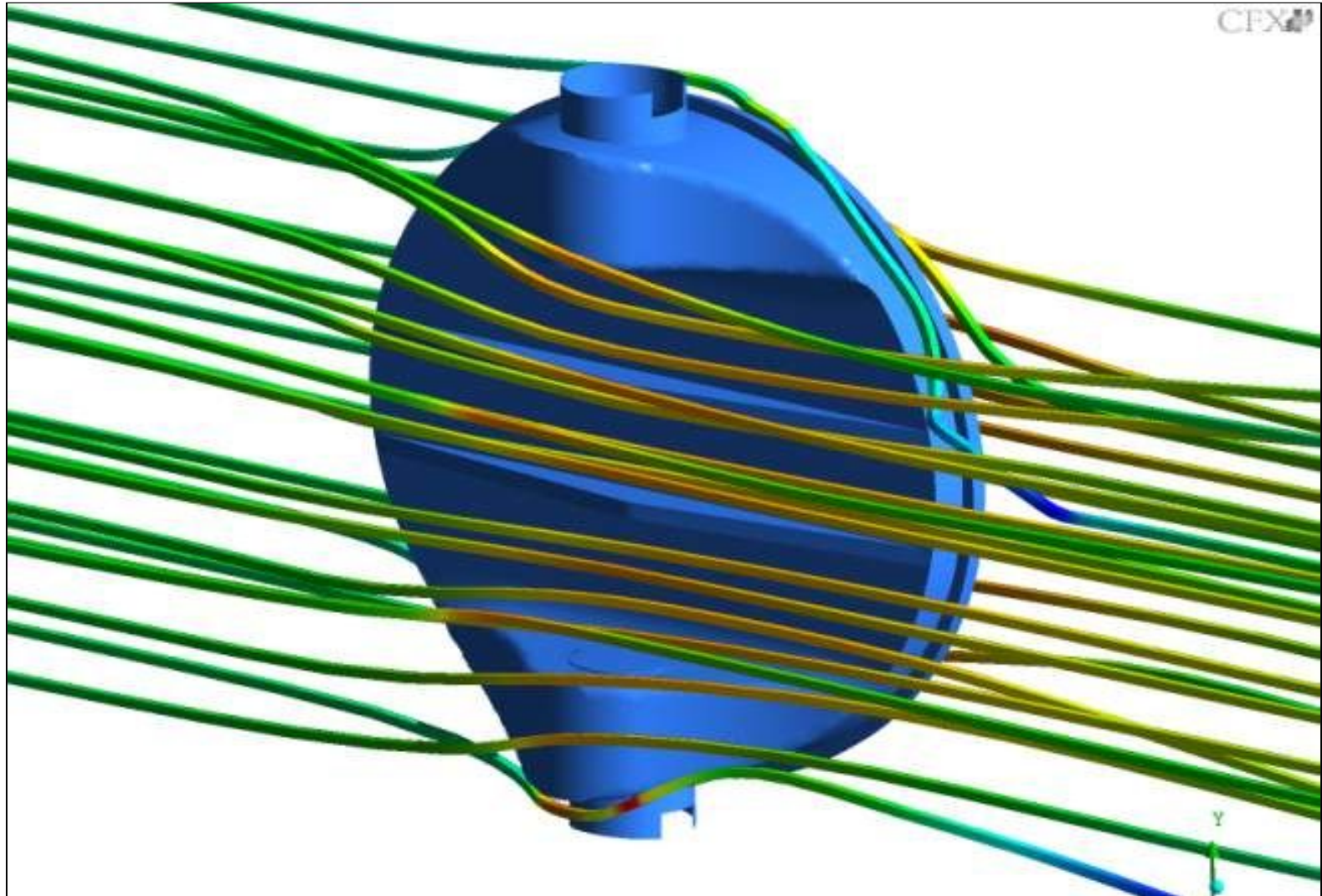
- Material change from SS to AISI leads to a cost reduction of 35% (66\$/pump).
- Shaft Sleeve weight is optimized by cast design.
- Reliability is ensured by the Shaft sleeve connection with Shaft through Press-fit design.
- Sealing is achieved through the O-rings and Loctite sealing compounds.



**Modified Configuration**

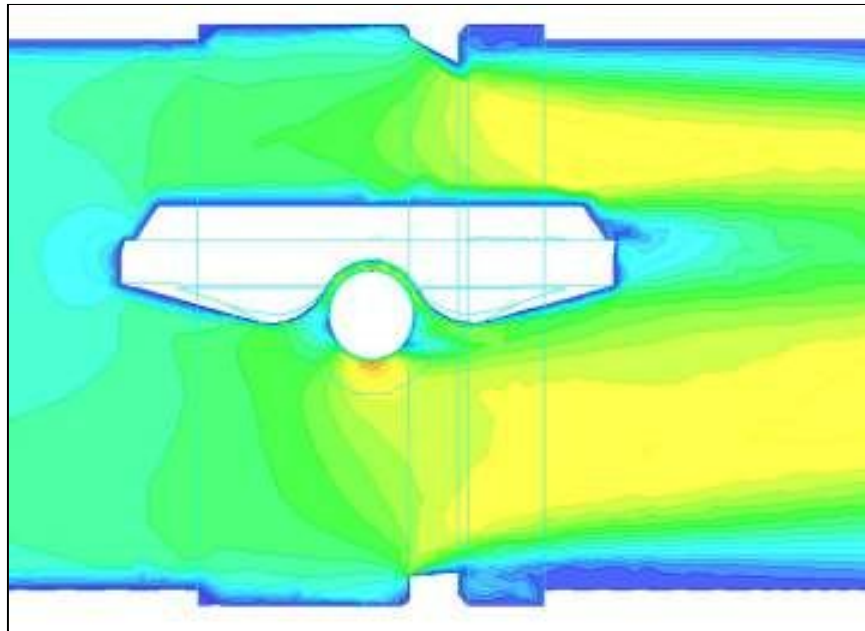
- The shaft cut is provided and the central core shaft is removed to reduce the blockage. Ribs are provided for structural integrity.
- Disc (valve) thickness reduced from 67.84 mm to 29.15 mm; new chamfer has been provided to have gradual area change.
- Seat bore diameter is increased from 236.6 mm to 243.2 mm. This is essentially to increase the flow area.
- Provided necessary fillets and smooth contours to reduce the flow separation due to sudden change in area.
- The inlet and outlet pipe diameters are retained same.

Flow streamlines

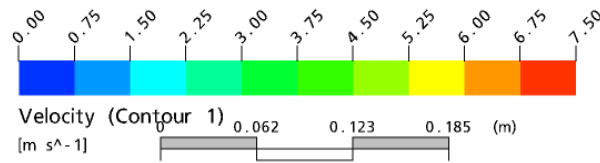
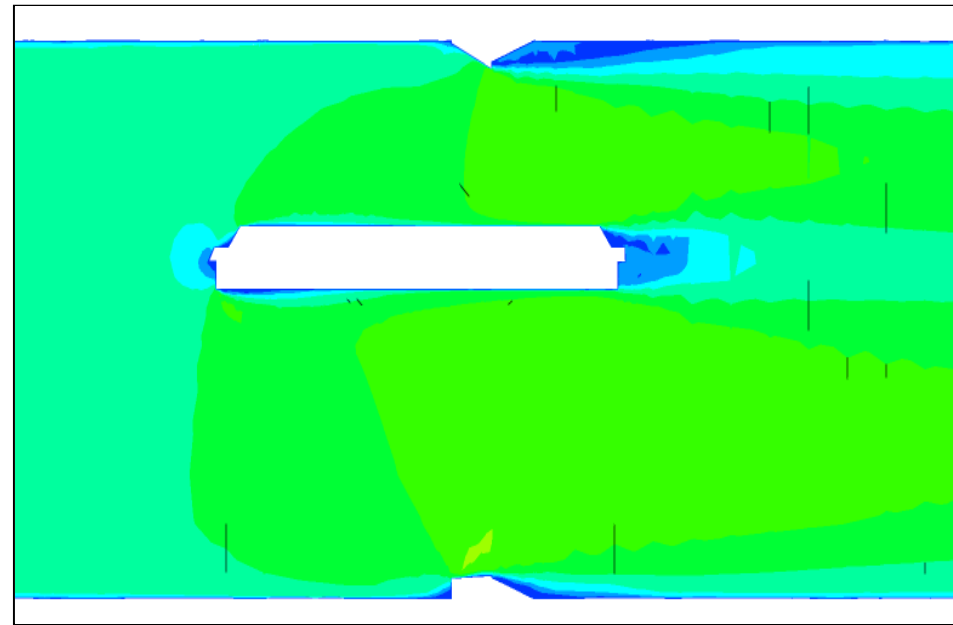


# Comparison of velocity contours for both configuration

Baseline design



Modified design



# Estimation of Flow Coefficient [ $C_v$ ]

$$C_v = \frac{Q}{N_1} \sqrt{\frac{\rho_1 / \rho_0}{\Delta p}}$$

$C_v$  = Flow coefficient [as per IEC 60534-2-1, 6.1.1.1, pp.13. ]

$Q$  = Volumetric flow rate, m<sup>3</sup>/h

$\rho_1$  = Density of fluid at location A

$\rho_0$  = Density of fluid at location B

$N_1$  = 8.65x10<sup>-2</sup> (Numerical constant based on units used in equation)

$\Delta p$  = Differential pressure between locations A & B ( $p_1 - p_2$ ), kPa

Configuration	Differential Pressure (kPa)	$C_v$ (m <sup>3</sup> /h)	% increase in $C_v$
Baseline	5.460	2226.0	-
Modified	2.924	3042.1	<b>36.6</b>

**The modified design gives energy savings of 40% and higher**

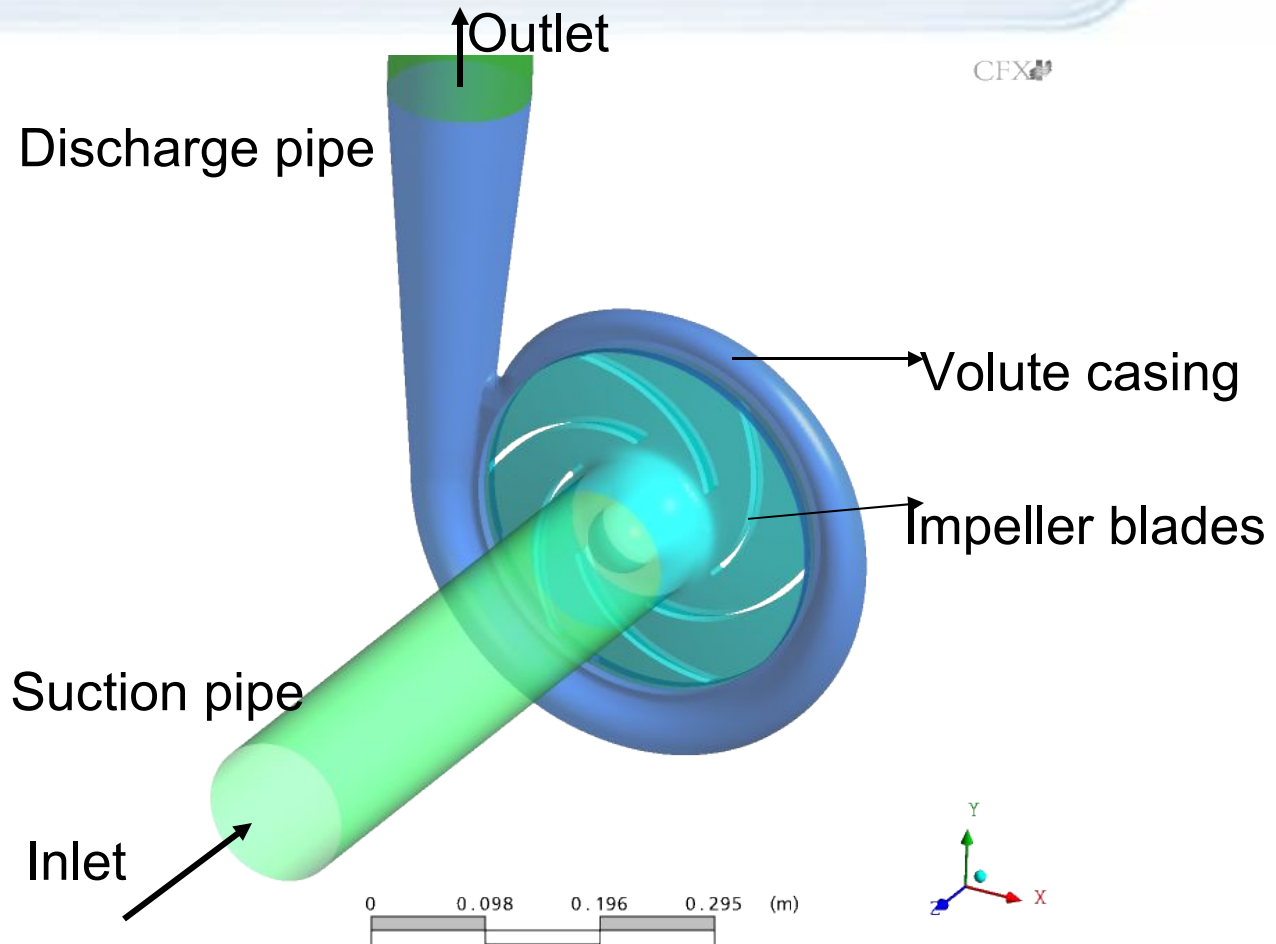
- Objective

To predict the pump performance in terms of net head and hydraulic efficiency.

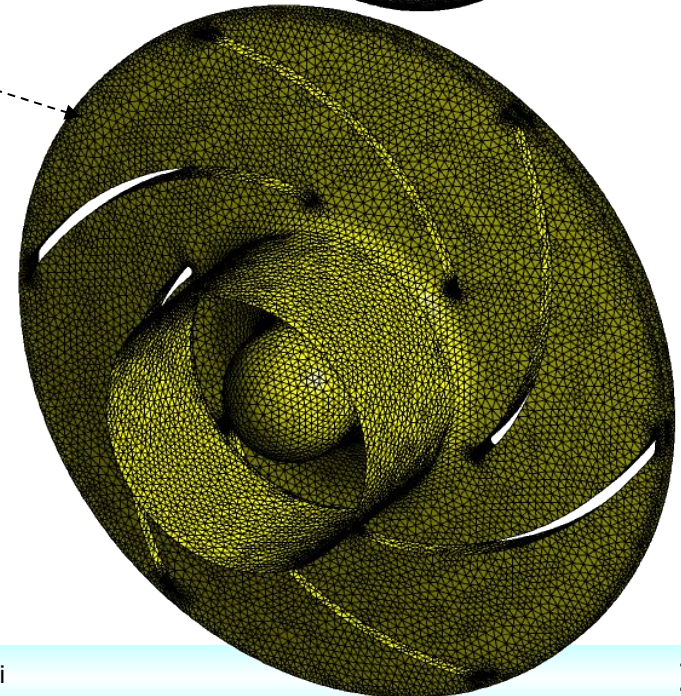
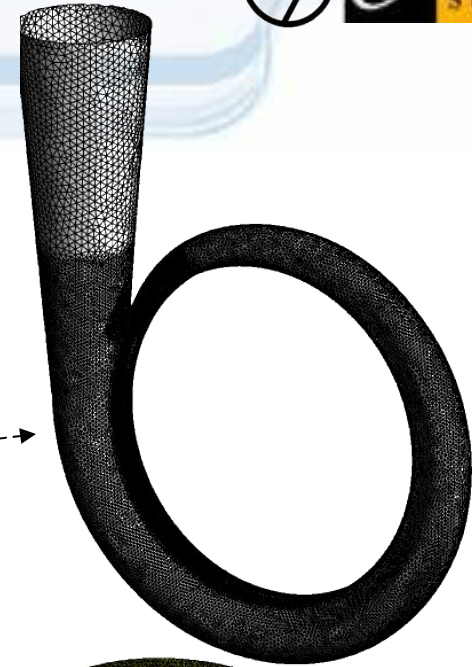
## 2. Details of Fluid Flow

- Complete 3-D simulation of the flow domain has been carried out using CFX<sup>®</sup> Ver 10.
- The flow has been modeled using incompressible, isothermal & turbulent flow (using SST turbulence model).
- The fluid medium for the analysis is water at STP
- Modeled using Multiple reference frame model with Frozen rotor interface

Impeller	: Rotating domain @ 1500 rpm
Casing	: stationary domain
Suction & discharge pipes	: stationary domain



**Schematic of the flow domain (Suction pipe, impeller, volute casing & discharge pipe)**



## **Mesh statistics:**

Number of Nodes: 476550

Number of Elements: 2379880

Tetrahedral: 2280779

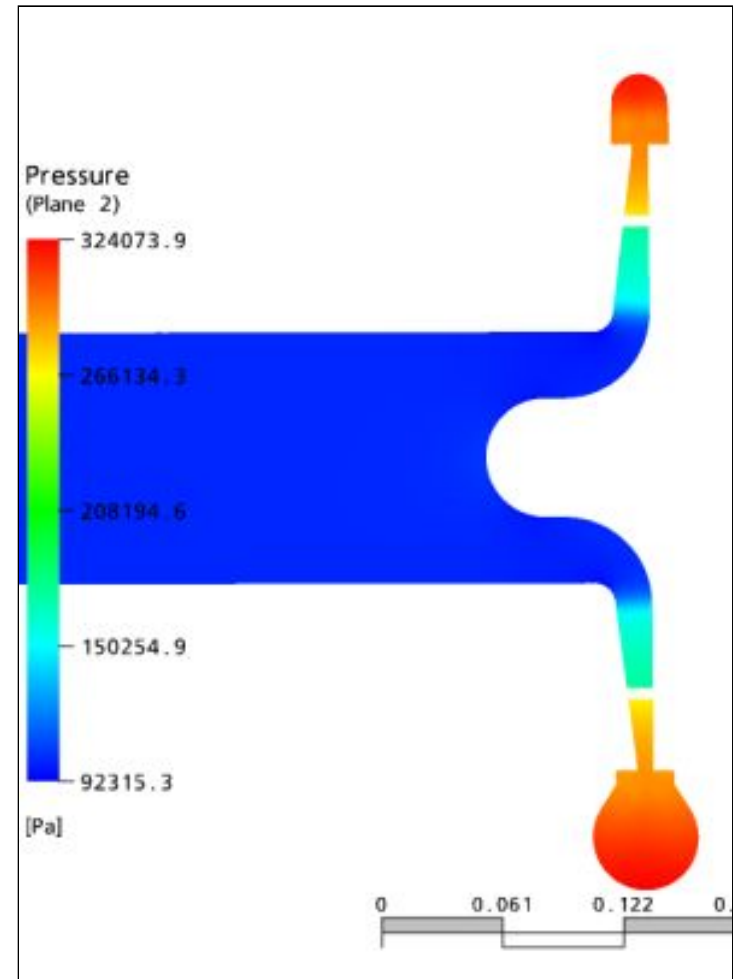
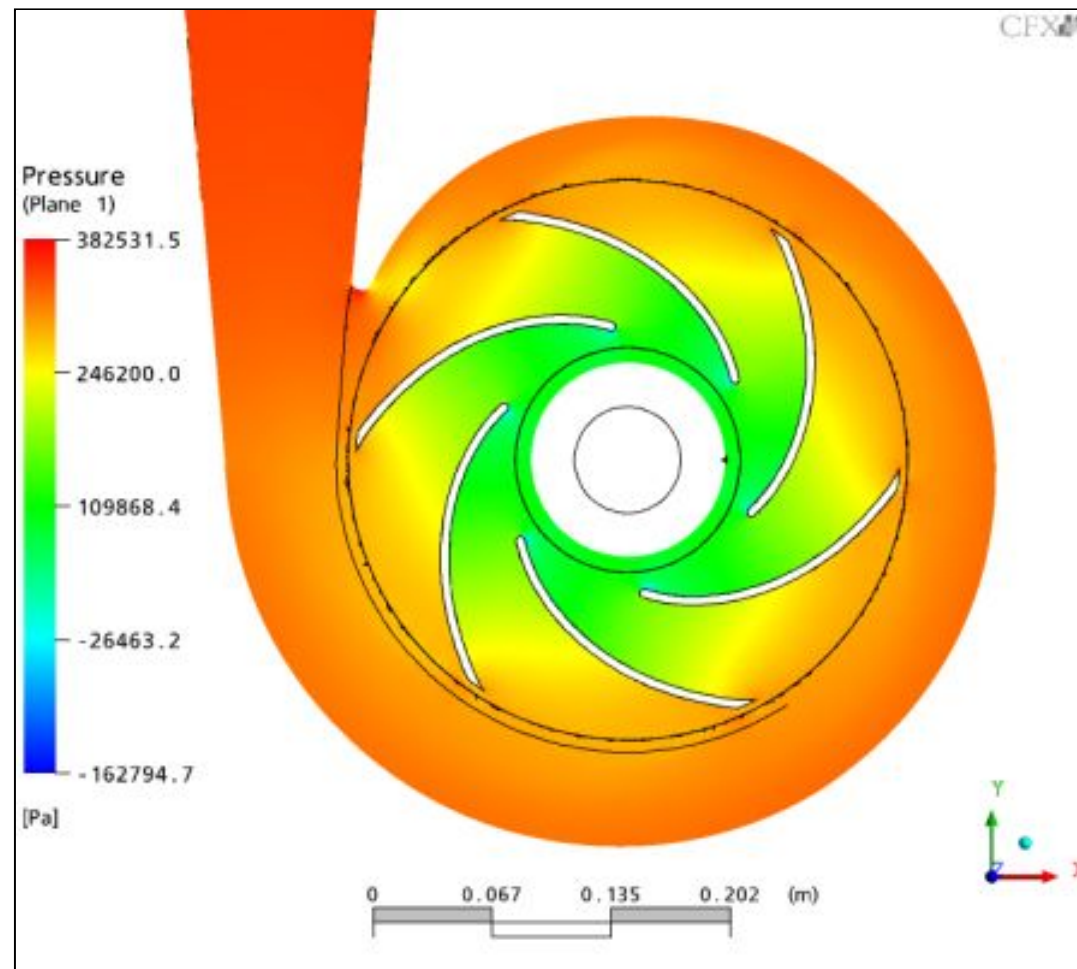
Wedges: 98496

Pyramids: 605

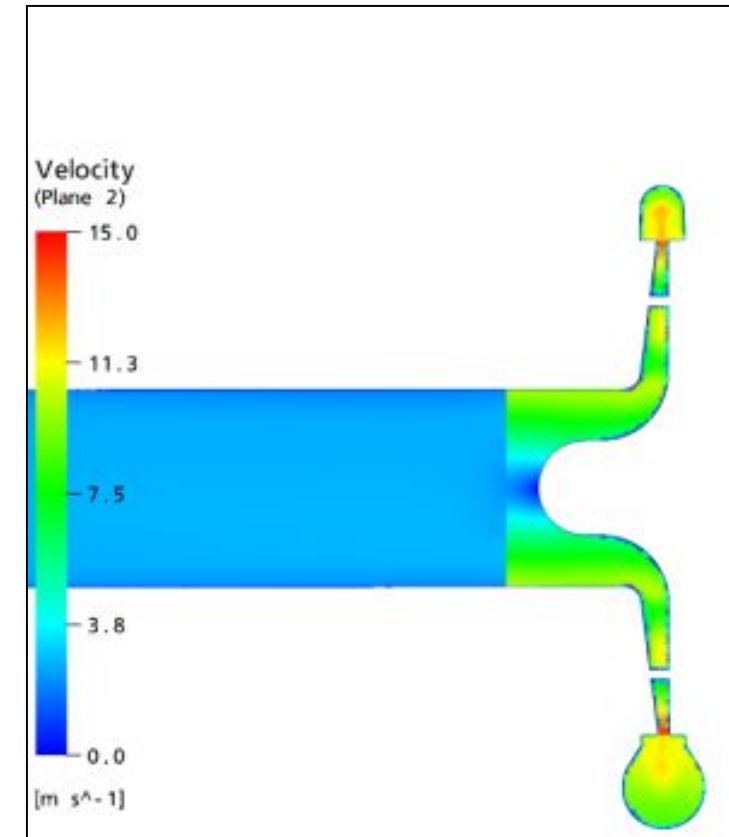
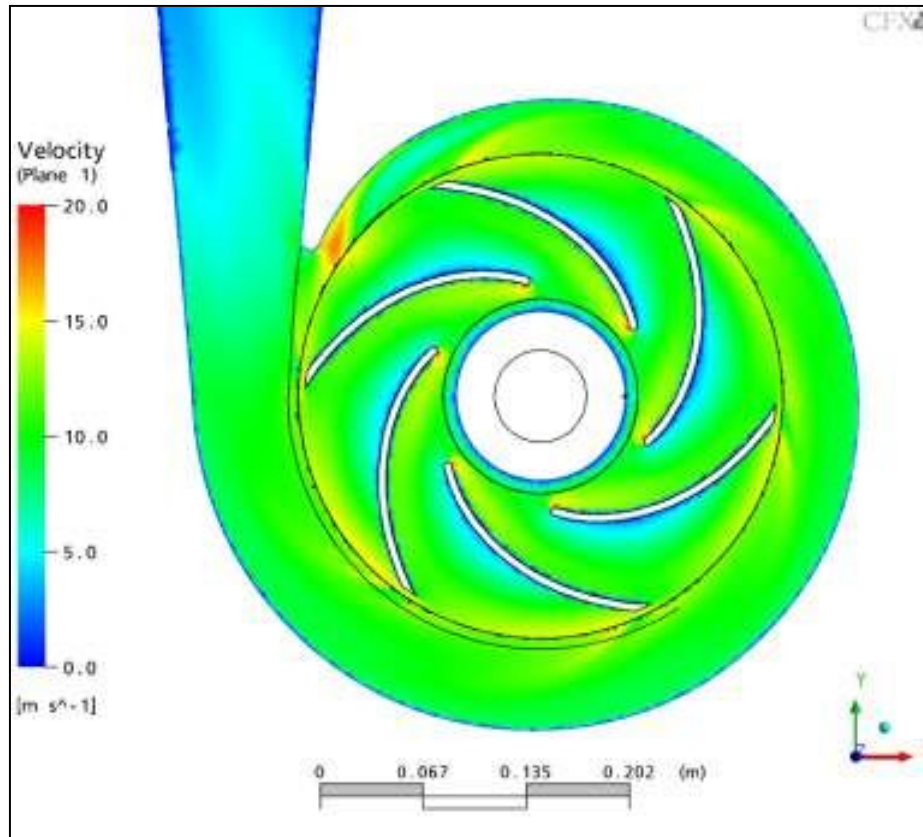
# Boundary Conditions (Design flow rate)

	Flow parameters	
Inlet	Static pressure [Pa]	101325
	Turbulence intensity	1%
	Eddy viscosity ratio	10
Outlet	Velocity [m/s]	2.526
Wall	Adiabatic, no slip & smooth	

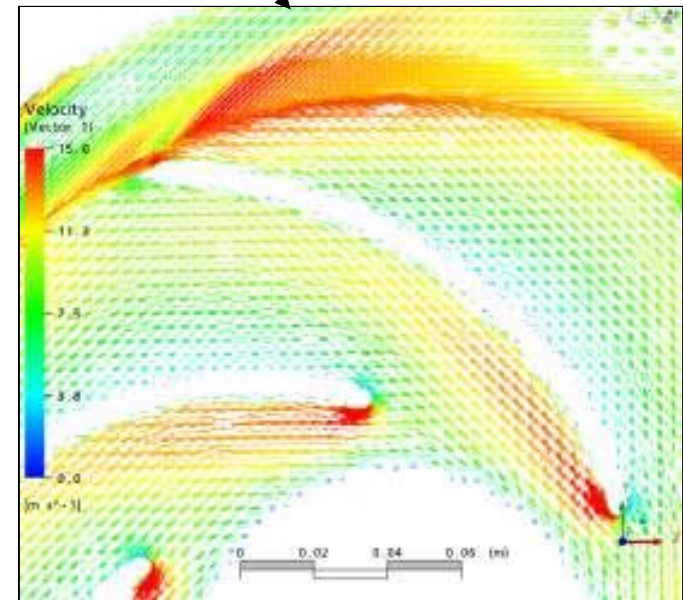
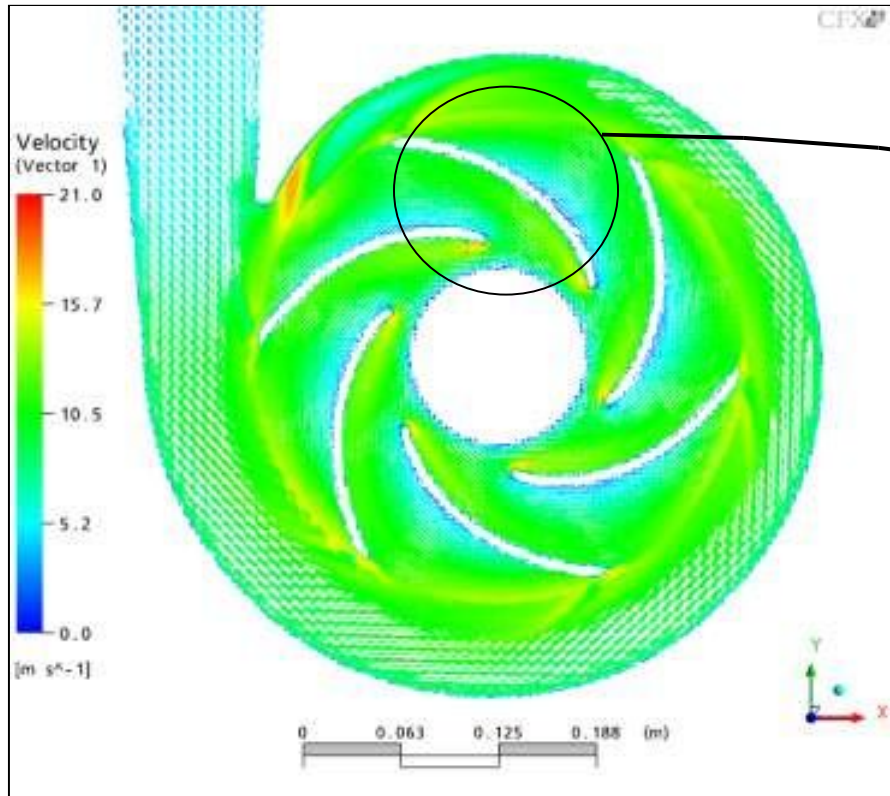
## Static Pressure distribution along blade-blade & Meridional view



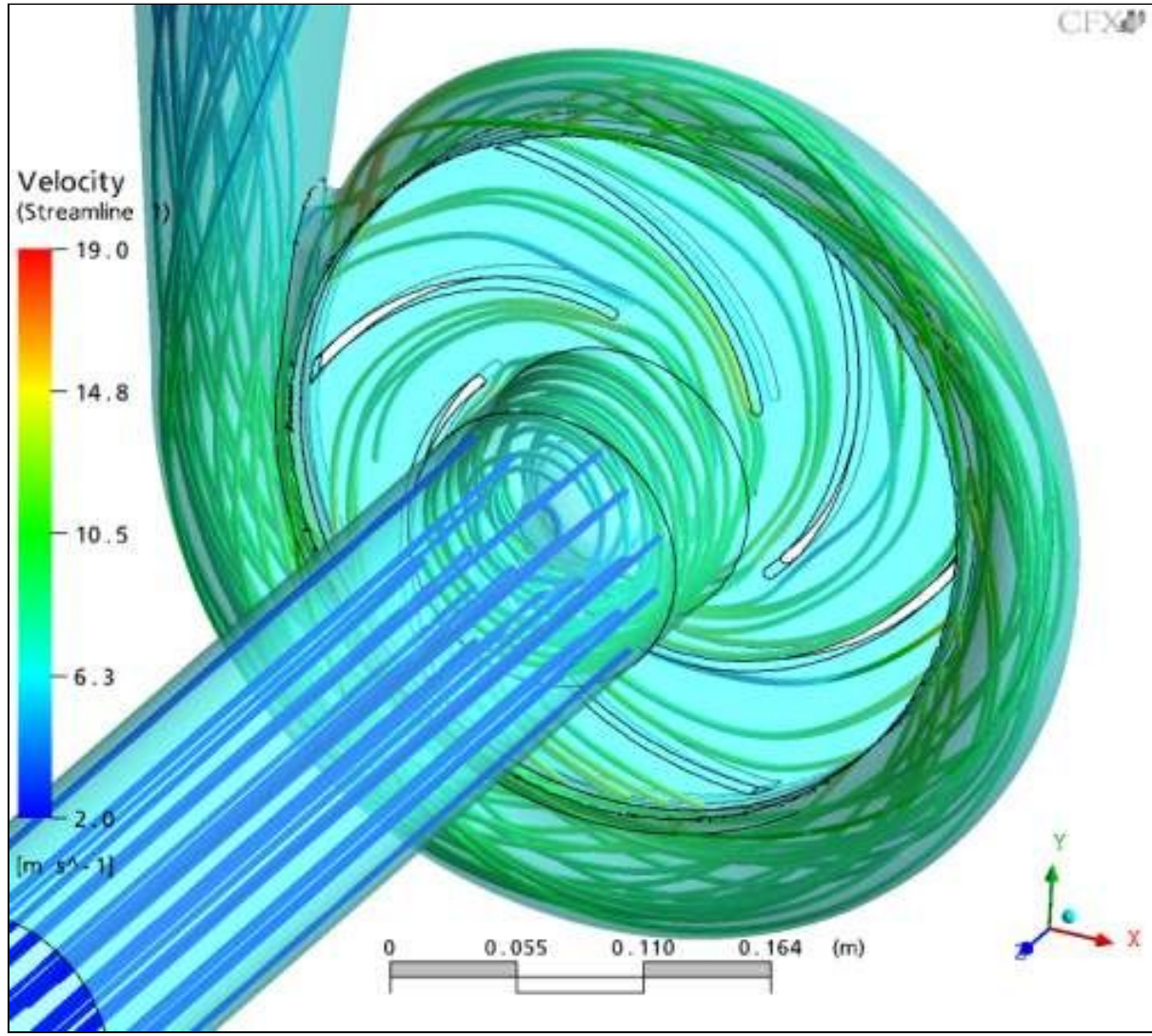
# Velocity distribution along blade-blade & Meridional view



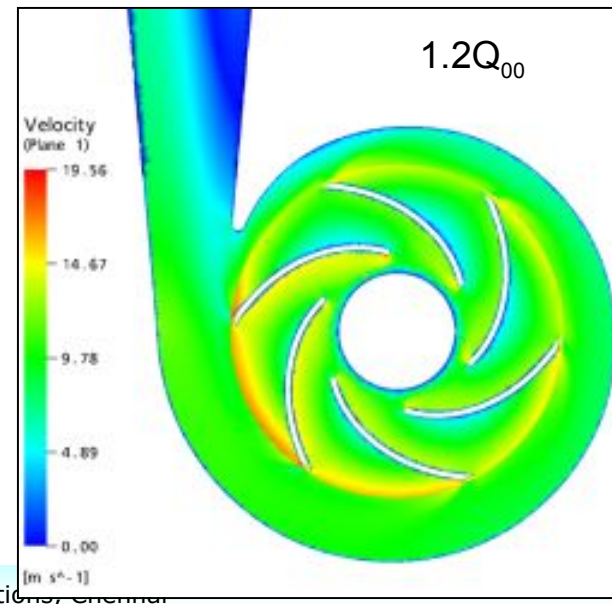
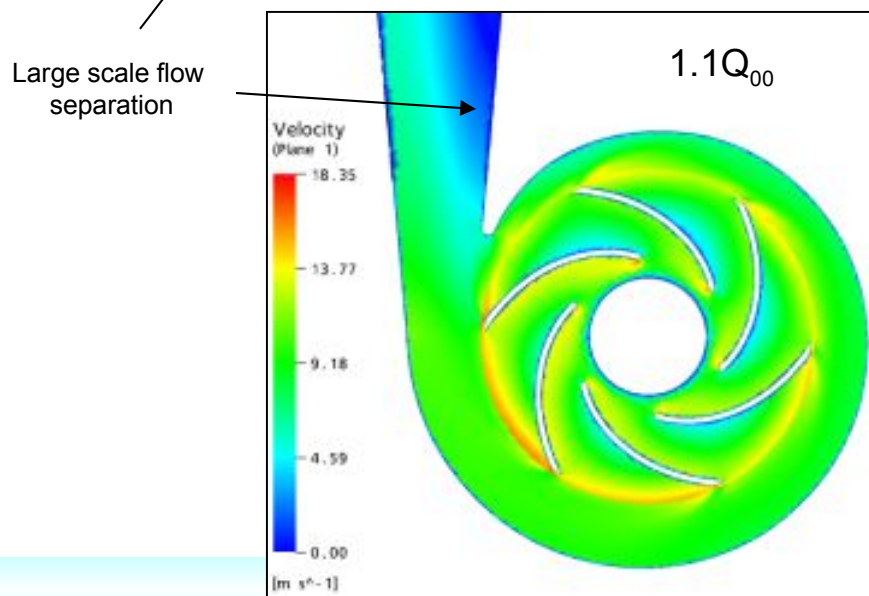
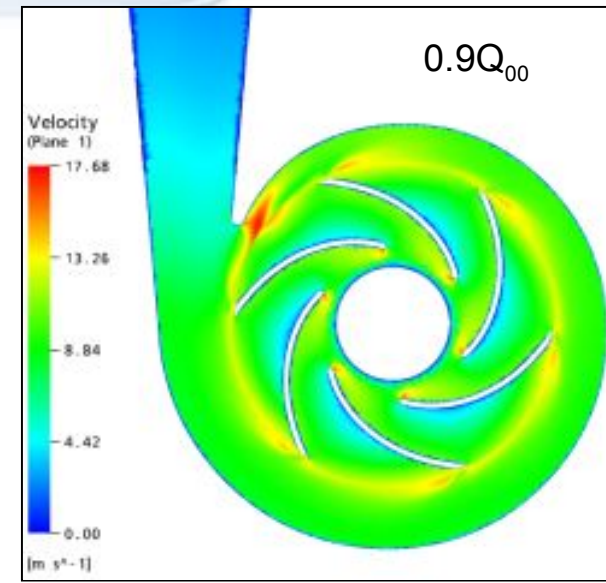
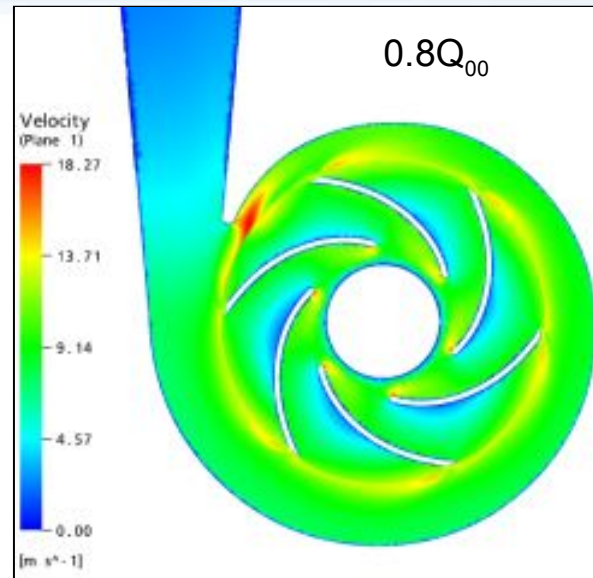
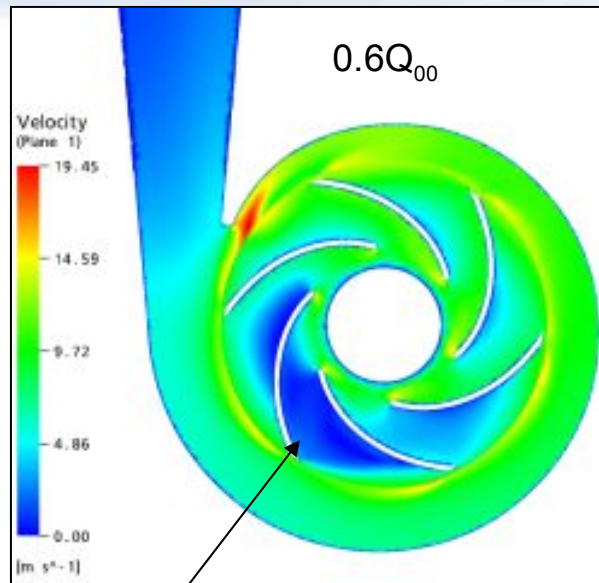
# Velocity vectors along blade-blade & Meridional view



# Stream lines through the impeller blades & casing

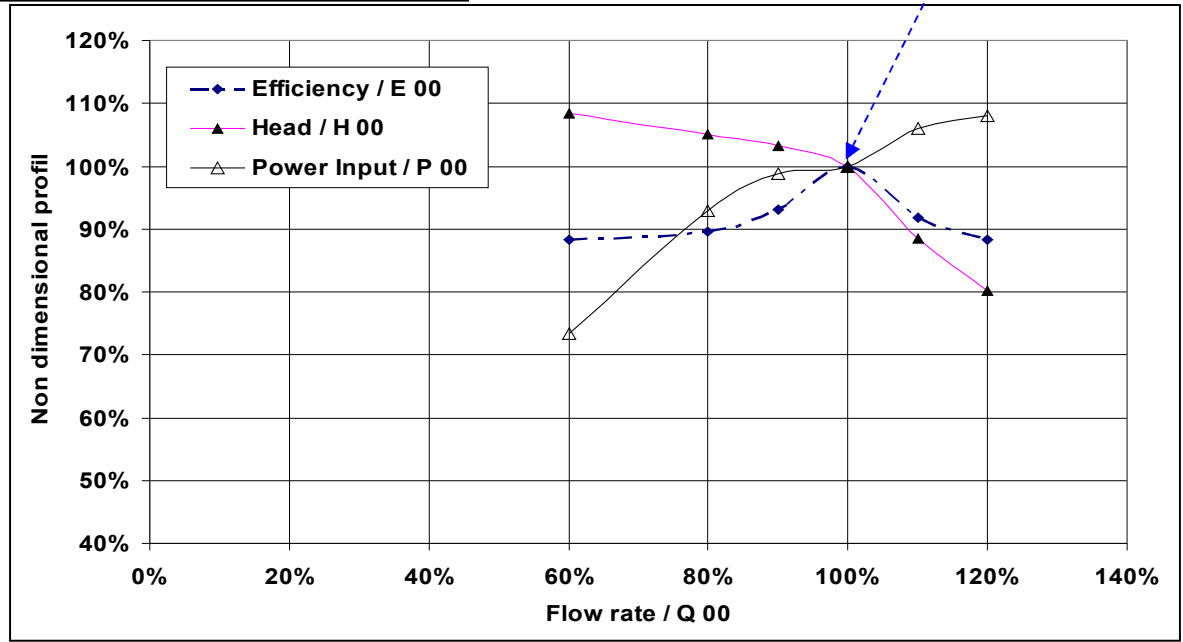


# Velocity distribution along impeller passages for off-design conditions



Parameters	0.6 Q <sub>00</sub>	0.8 Q <sub>00</sub>	0.9 Q <sub>00</sub>	Design flow rate (Q <sub>00</sub> )	1.1 Q <sub>00</sub>	1.2 Q <sub>00</sub>
Inlet Static Pressure [Pa]	101325	101325	101325	101325	101325	101325
Outlet Static pressure [Pa]	370627	362372	357689	350062	320339	299136
Net head (m) (H=ΔP/ρg)	27.46	26.62	26.14	25.38	22.46	20.32
Hydraulic efficiency [%]	76.01	77.72	80.75	86.11	78.99	76.52

Best Efficiency point



Thank You  
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