Intelligent design of turbomachinery together with CAESES

Nanjing Tianfu Software



Company Introduction



Name	NanJing TianFu Software Co., Ltd.			
CEO	Zhang Ming (Ph.D)			
Establishment Date	2011.5.20			
Number of employees	45			
Main business	Development and sales of CAE software Design and optimization of turbomachinary			
Branch	Ningbo Zhigaodian FsTech Japan			
Partner	FRIENDSHIP SYSTEMS Tsinghua University DNV-GL China Flowtech CFD Support HydroComp			

Company Introduction

• Products

AIPump---Pump design tool AIFan----Fan design tool

• Highlights

Obtain a high performance model by the requirements just like flow rate, head (pressure rise) and rotational speed.

Generate CAESES script files and create fully parametric model in CAESES automatically, set the CFD software connection and optimization method well for performance analysis and optimization.



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- AIPUMP is an intelligent pump design software, which can quickly design mixed flow and centrifugal pump impeller with high performance.
- The software relies on the advanced pump design algorithm of Tsinghua University and our experimental database.





	\lambda Design input			
	Volume flow(m^3/h):	200		
	Head(m):	20]	
	Rotation speed(rpm):	2950		
1	Density(kg/m^3):	998.2]	
	Temperature (°C):	20		

- We only need to input the values of volume flow rate, Head, Rotational speed, and then AIPump can generate three-dimensional impeller model automatically.
- We can also adjust the meridional flow passage, the LE curve, the theta/beta angle and thickness distribution of the blade flexibly.



Meridional flow passage adjustment







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We can quickly obtain the performance curve of the pump using S2 method based on experimental loss models.



• Basing on the results from S2 analysis, we can optimize the flow passage and blade shape with the algorithm in the software itself. 2 AIPump

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- The software has a smooth data change with a variety of CAD and CAE software, such as
 GeomTurbo for Numeca, Curve for Turbogrid and iges/step format.
- And we can create CFX and CAESES scripts and run them directly.

AIPump with CAESES

• We can generate the .fsc file and then create fully parametric model in CAESES

automatically.

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AIPump with CAESES

• We have set the variables, software connection and Optimization method by default, but

you can still change them manually.

• Then we can do the 3D CFD simulation and optimization for the pump model.

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• The design and optimization process of AIPump





AIPump case

Flow rate	m^3/h	40
Head	m	54
Rotational speed	r/min	2950
Specific speed		57
Impeller diameter (D2)	mm	204.29
Outlet width (b2)	mm	8.1
Suction diameter (DS)	mm	64.72
CFD computational Head	m	69.23
CFD computational efficiency	%	95.28



Specific speed=57



AIPump case

Flow rate	m^3/h	100	
Head	m	40	
Rotational speed	r/min	2950	
Specific speed		112.8	
Impeller diameter (D2)	mm	184.95	
Outlet width (b2)	mm	15.95	
Suction diameter (DS)	mm	87.08	
CFD computational Head	m	47.85	
CFD computational efficiency	%	97.56	

Specific speed = 112



AIPump case

Flow rate	m^3/h	200	
Head	m	40	
Rotational speed	r/min	2950	
Specific speed		160	
Impeller diameter (D2)	mm	196.74	
Outlet width (b2)	mm	23.79	
Suction diameter (DS)	mm	109.67	
CFD computational Head	m	43.56	
CFD computational efficiency	%	96.34	

Specific speed = 160

All the impellers have a high efficiency in CFD simulation.

3 AIFan

- AIFan is an advanced fan design software developed by Nanjing Tianfu.
- We can get a high-performance fan model quickly after inputting volume flow rate ,total pressure rise, rotational speed and the expected efficiency.
- Now in this version we can design the axial fan with single rotor, tandem rotor with the same or opposite rotation direction, or with postpositioned stator.

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4	402.17	23.46	31.33	13.71	30.32	5.84	0.66	152.59	0.69	E 21 0
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- AIFan is based on the experimental database and loss model with high precision.
- Use the high performance fan profile.
- Design the twist of blade with controllable vortex method.
- Quick evaluation for the performance of the design result with high accuracy .

		Preliminary Performance Assessment	P = 1199	. 85650 (Pa)		Q = 7.20255(m ²	3/s)		
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Pototo Saudi	1450				Calculate Circulation	Middle:	17.68		
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lotal fressure increase.	1200		pa			Optimal Value:	0.790	(Employed eventually)	
T.4.1 B	1200				Calculate Hub ratio	Minimum Value:	0.667		
Volue Flow Rate:	7.5		m^3/s			Maximum Value:	0.969		
			_			Impeller Outer Diameter :	979.1	mm	

Performance Index Parameter Calculation Design Result Blade Modelin



- Full three-dimensional blade modeling with sweep and skew.
- Multiple format data output(gemoturbo, curve, step).



Blade Modeling







• Also, we can generate the .fsc file and then create fully parametric model in CAESES automatically.

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- We have set the variables, software connection and Optimization by default, but you can still change them manually.
- Then we can do the 3D CFD simulation and optimization for the fan model.





The design and optimization process of AIFan ٠





- We have designed some ventilators for coal mine, fans for the subway train, and the ducted fans for the unmanned aerial vehicle.
- And the performance of the design results all meet or exceed customers' requirements.



Volume Flow Rate(m^3/s)	Total Pressure Rise(Pa)	Efficiency	Thrust(N)	Power(KW)
2.9077	876	0.838	170	3.05
2.8904	995	0.853	163	3.3 🦿
2.7063	1117	0.863	155	3.51
2.5981	1240	0.868	147	3.72

4

TurboExchanger

- And if you have some fan or pump models already, we can change it to fully parametric model by UG and CAESES, and then do the optimization.
- We developed the tool named TurboExchanger to export the impeller model with geomturbo format in UG, and then generate a parametric impeller model in CAESES.

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TurboExchanger

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- We import the geomturbo file into CAESES, and calculate the parameters with Feature automatically.
- Then we can get a parametric model to do the simulation and optimization.









Conclusion

- With the help of these tools, we now put CAESES into our design workflow perfectly.
- We can design and optimize a new fan/pump model quickly.
- We can also improve the performance of an existing model in a faster and more convenient way.
- CAESES can be more helpful and efficient if combined with our tools.

THANK YOU



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