Flexware®
Turbomachinery Engineers
A Veteran & Employee Owned Small Business

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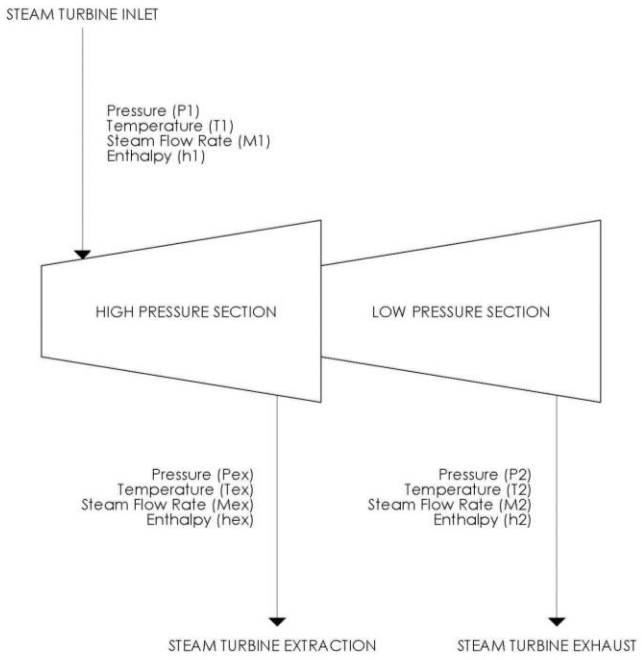
Condensing Extraction Turbine Calculation Using Flex Live Software



Whether completing a performance calculation on an iso-cooled compressor, sidestream compressor or extraction turbine, performance calculations are best completed section by section. And, the OEM should provide sectional performance curves as well as the overall curves.

Note that since the exhaust conditions are not easily determined on a condensing turbine, the driven power of the compressor or generator is used in the calculations as an input value.

Total power of the compressor for this example was determined from testing to be 7,239 HP and confirmed by comparing the compressor work input to the OEM predicted value.

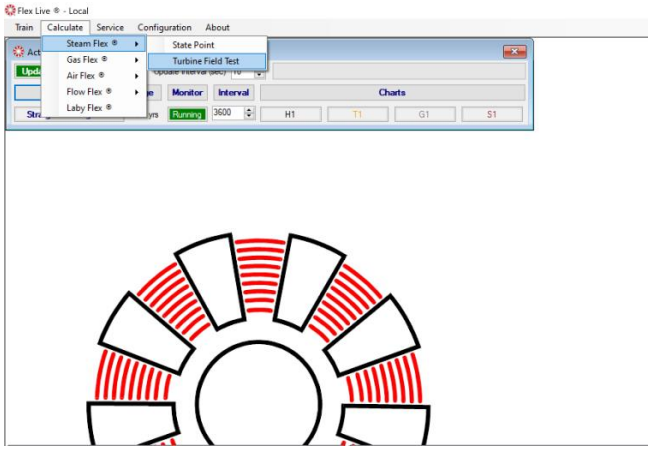
The power for the high-pressure section was determined to be 3,339HP as shown below using Flex Live. Section 2 power is thus 7,239-3,339=3900 HP

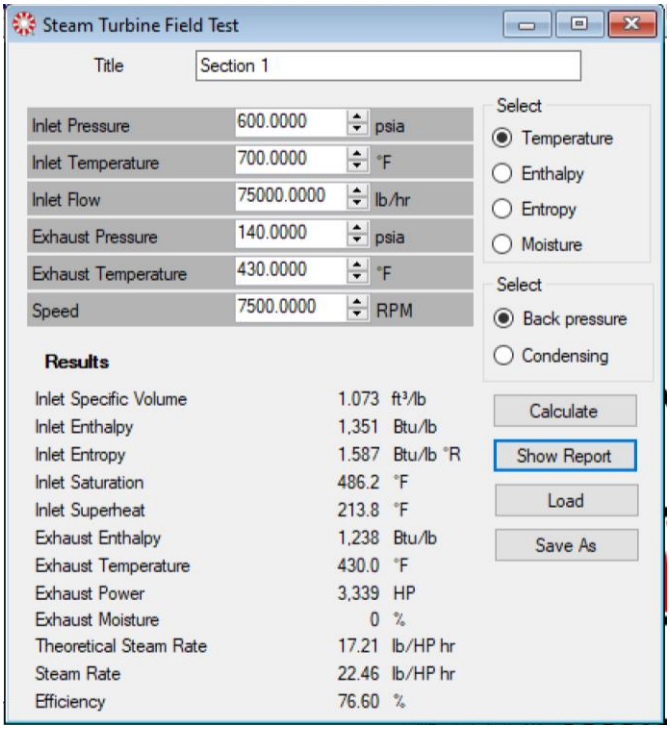
For the exhaust conditions for section #1, use the extraction pressure and temperature.

For the inlet conditions for section #2 use the extraction pressure and temperature.

Section 1, High pressure section, back pressure turbine

Input Data:
Inlet steam pressure 600 psia
Inlet steam temperature 700 F
Exhaust (extraction) steam pressure 140 psia
Exhaust (extraction) steam temperature 430 F
Inlet steam flow rate 75,000 lb/hr
Results:
Steam Power 3,339 HP
Overall efficiency 76.6%





Flex Live ® Steam Turbine Field Test

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Description: Section 1

Inputs	Units	Value
Inlet Pressure	psia	600.0
Inlet Temperature	°F	700.0
Inlet Flow	lb/hr	75,000
Exhaust Pressure	psia	140.0
Exhaust Temperature	°F	430.0
Speed	RPM	7,500

Overall Results	Units	Value
Exhaust Power	HP	3,339
Theoretical Steam Rate	lb/HP hr	17.21
Steam Rate	lb/HP hr	22.46
Efficiency	%	76.60

State Point Results	Units	Inlet	Exhaust
Specific Volume	ft³/lb	1.073	3.618
Pressure	psia	600.0	140.0
Temperature	°F	700.0	430.0
Enthalpy	Btu/lb	1,351	1,238
Entropy	Btu/lb °R	1.587	1.628
Mass Flow	lb/hr	75,000	75,000
Saturation Temperature	°F	486.2	353.0
Superheat	°F	213.8	76.98
Moisture	%	0	0

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Analysis via Gas Flex ®, a BWR gas properties program
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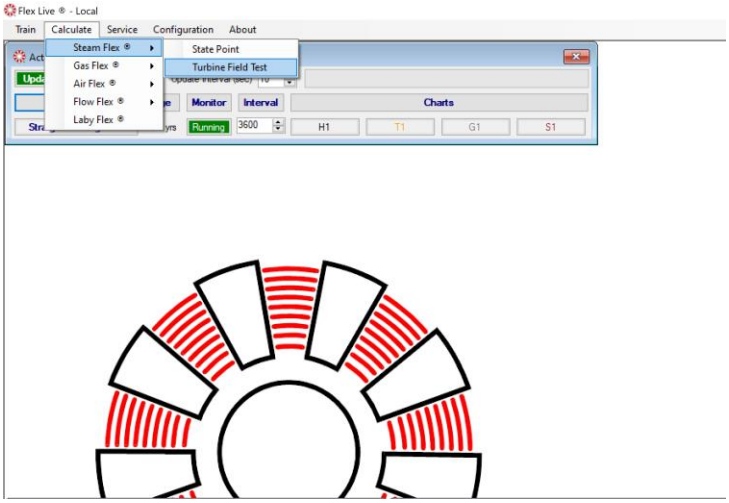
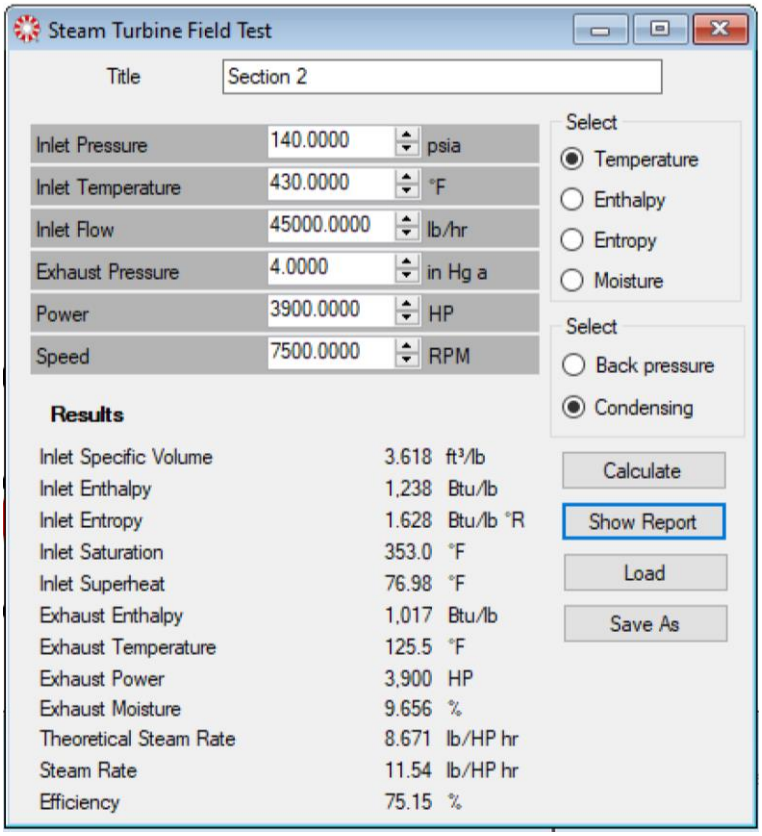
Section 2 – Low pressure section, Condensing steam turbine

Input Data:
Inlet (extraction) steam pressure 140 psia
Inlet (extraction) steam temperature 430 F
Exhaust steam pressure 4 in Hg a
Steam power 3,900 HP
Inlet steam flow rate 45,000 lb/hr
Results:
Overall efficiency 75.2%
Exhaust moisture 9.7%





Flex Live ® Steam Turbine Field Test

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Description: Section 2

Inputs	Units	Value
Inlet Pressure	psia	140.0
Inlet Temperature	°F	430.0
Inlet Flow	lb/hr	45,000
Exhaust Pressure	in Hg a	4.000
Power	HP	3,900
Speed	RPM	7,500

Overall Results	Units	Value
Exhaust Power	HP	3,900
Theoretical Steam Rate	lb/HP hr	8.671
Steam Rate	lb/HP hr	11.54
Efficiency	%	75.15

State Point Results	Units	Inlet	Exhaust
Specific Volume	ft³/lb	3.618	158.7
Pressure	psia	140.0	1.965
Temperature	°F	430.0	125.5
Enthalpy	Btu/lb	1,238	1,017
Entropy	Btu/lb °R	1.628	1.752
Mass Flow	lb/hr	45,000	45,000
Saturation Temperature	°F	353.0	125.5
Superheat	°F	76.98	0
Moisture	%	0	9.656

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12-Jul-23