



ASIA TURBOMACHINERY & PUMP SYMPOSIUM

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How the Application of Turboexpanders with Variable Inlet Guide Vanes Supports Increased Flexibility in LNG and LPG Production

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Radial Inflow Turbine Turboexpander



Turboexpander

Background

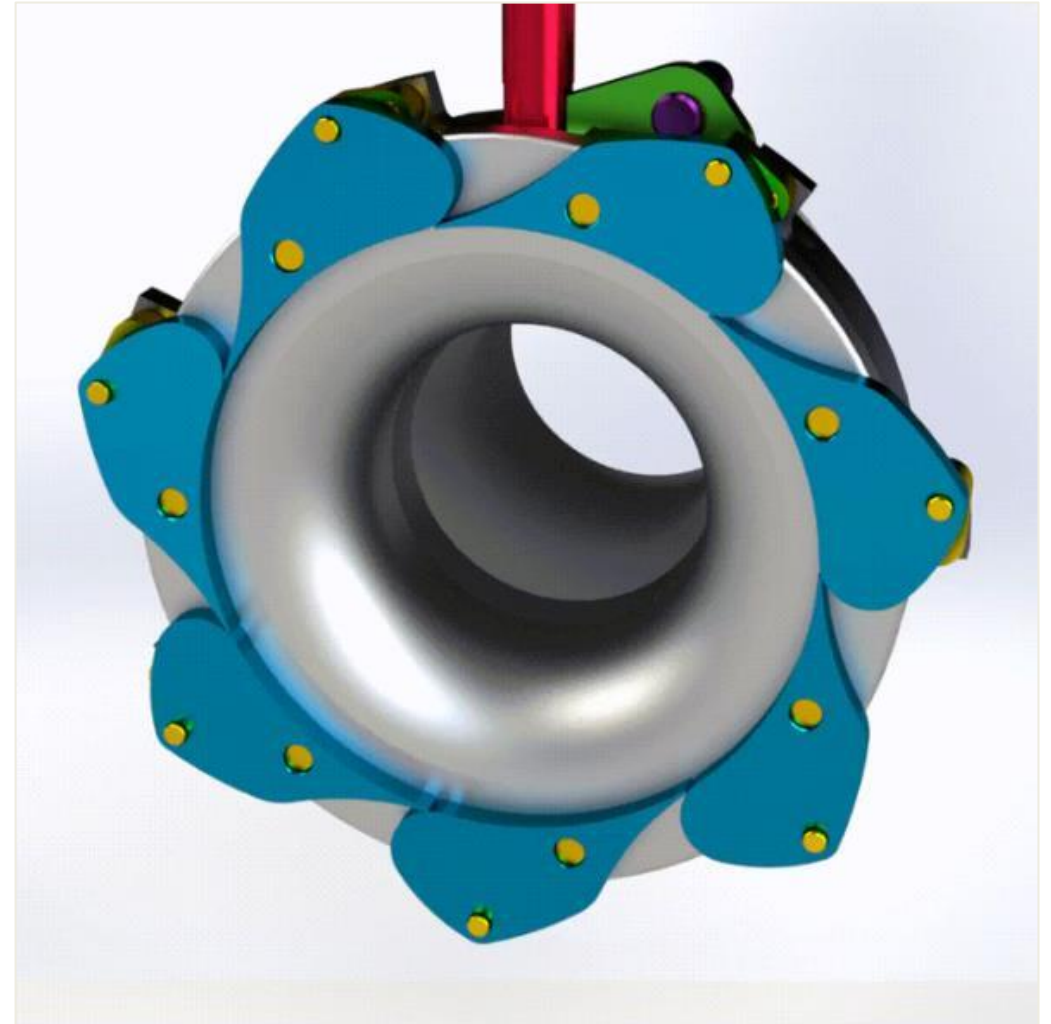
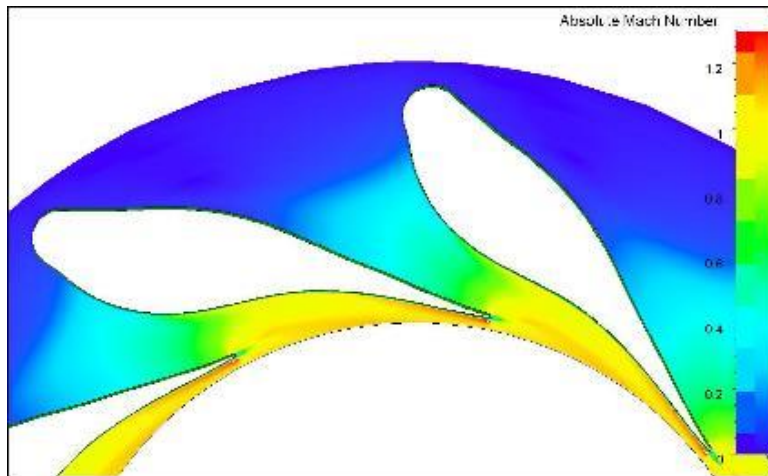
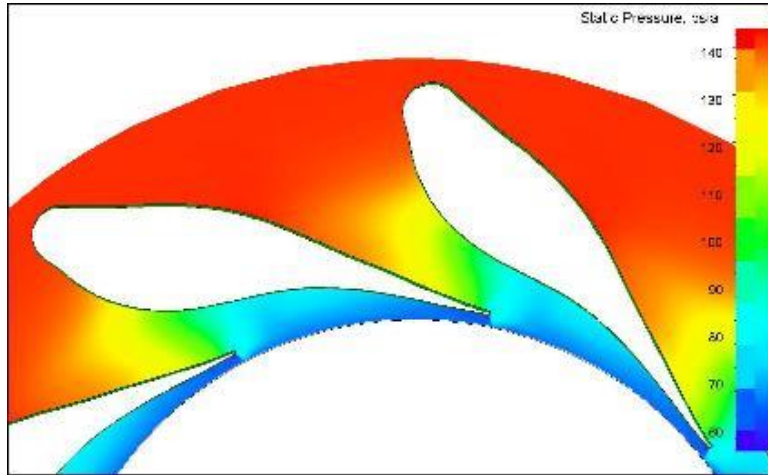
- Originally installed in air separation plants in 1930s
- First US Natural Gas installation in 1960
- Common use in LNG and LPG production

Design

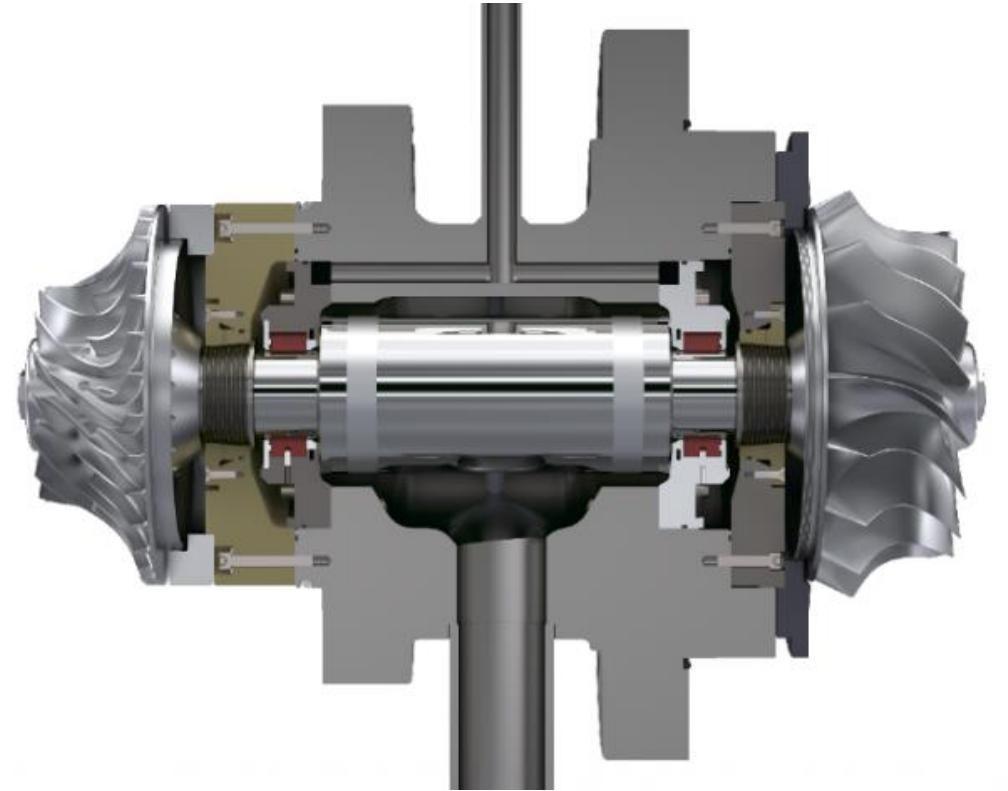
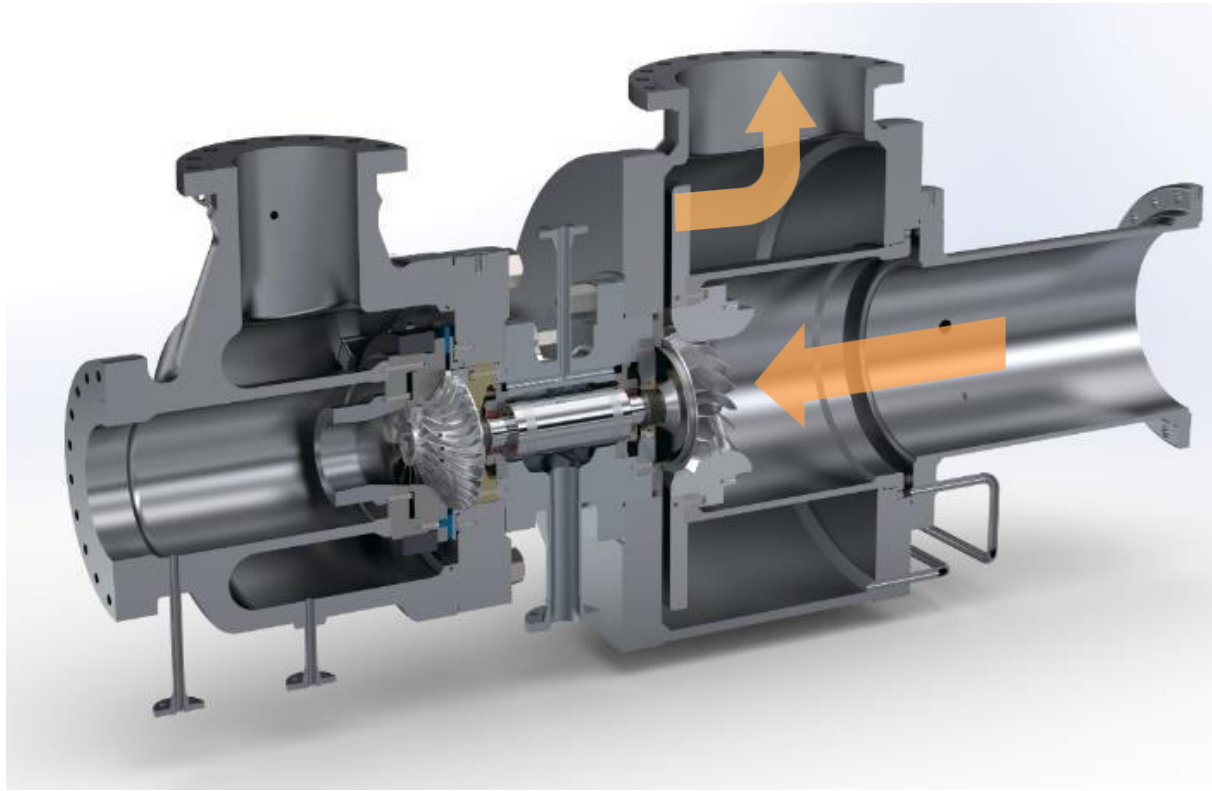
- Radial Inlet, Axial Discharge
- 50% Reaction = $\frac{\Delta h_{impeller}}{\Delta h_{stage}}$



Variable Inlet Guide Vanes



Expander Compressor



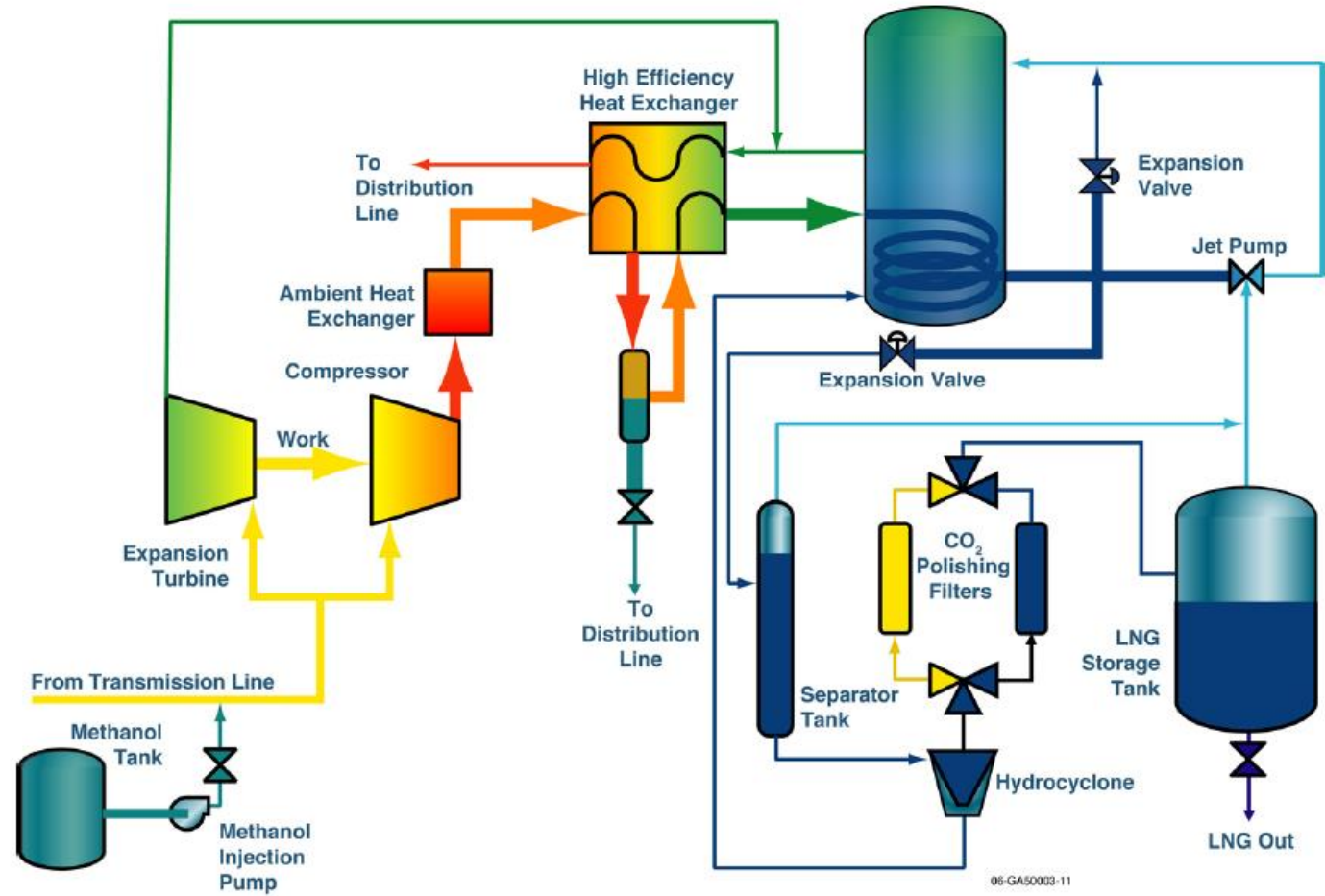
NuBlu Energy Small-Scale LNG



NuBlu Energy Small-Scale LNG

US Idaho National Laboratory
Patented Technology

Maximizes liquefaction efficiency
through pressure letdown
energy recovery



NuBlu Energy Small-Scale LNG

Inlet Press.		Outlet Press.		Liquefaction Efficiency			
(psig)	(Bar)	(psig)	(Bar)	kWh/Ton	kWh/Gal	kWh/Liter	Gal/hp
400	28.59	60	5.15	157	0.25	0.07	71
500	35.49	60	5.15	134	0.22	0.06	83
600	42.38	60	5.15	88	0.14	0.04	127
700	49.28	60	5.15	73	0.12	0.03	152
800	56.17	60	5.15	67	0.11	0.03	166



NuBlu Energy Small-Scale LNG

Inlet Press.		Outlet Press.		Liquefaction Efficiency			
(psig)	(Bar)	(psig)	(Bar)	kWh/Ton	kWh/Gal	kWh/Liter	Gal/hp
500	35.49	400	28.59	586	0.94	0.25	19
600	42.38	400	28.59	502	0.81	0.21	22
700	49.28	400	28.59	438	0.71	0.19	25
800	56.17	400	28.59	398	0.64	0.17	28
900	63.07	400	28.59	346	0.556	0.147	32



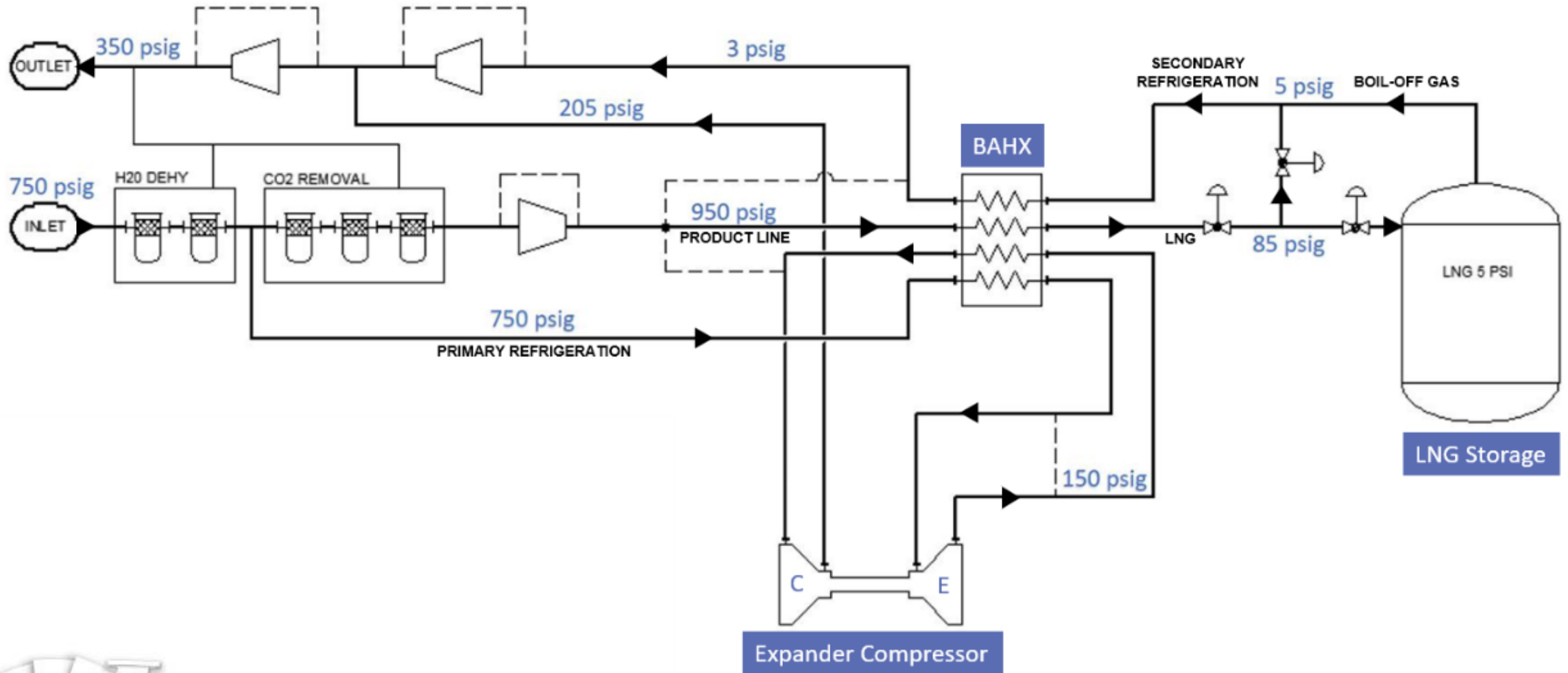
NuBlu Energy Small-Scale LNG (Port Allen)



NuBlu Energy Port Allen LNG Plant



Port Allen



Port Allen – Liquefaction Module

Expander Compressor /w Aux.
Lube Oil System

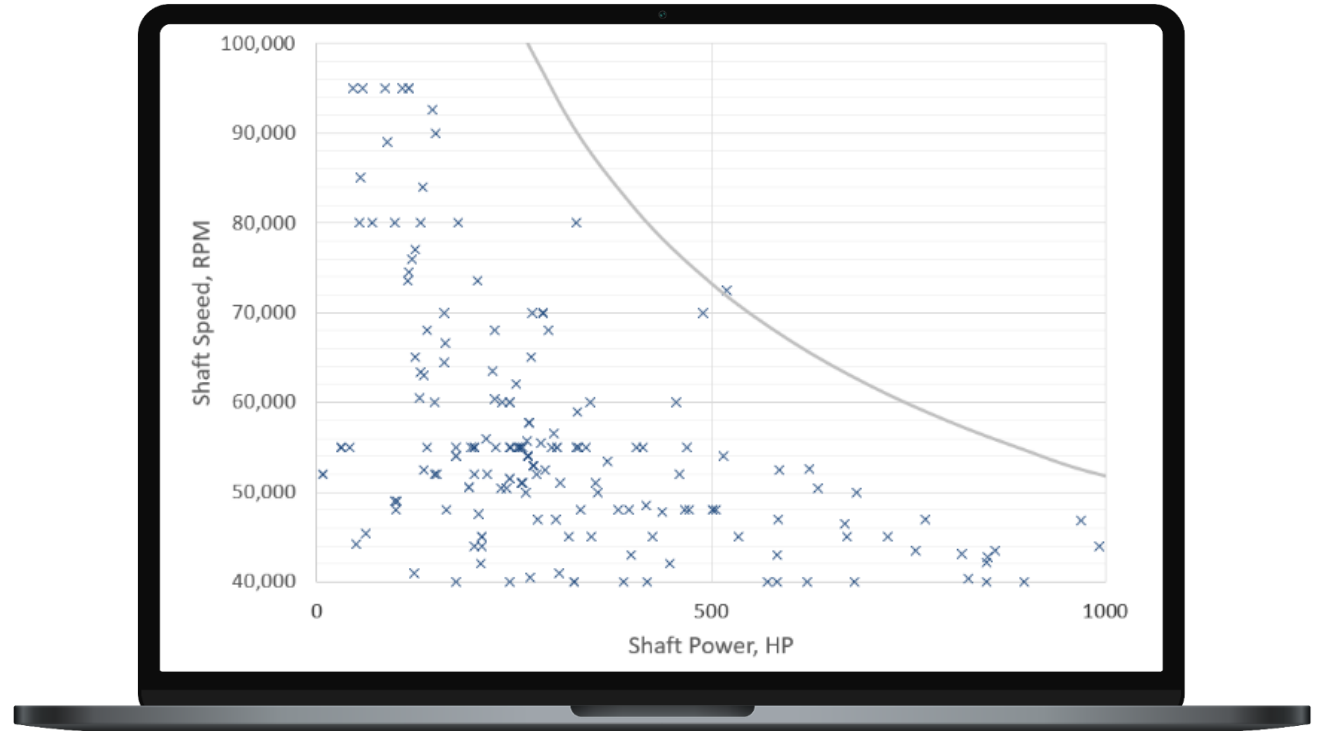
JT Bypass & Anti-Surge Loop

Brazed Aluminum Heat Exchanger

Liquid JT



Port Allen – EC



Port Allen – EC Operation

Inlet Condition	Units	36k gpd (Design Point)		20k gpd		4k gpd (Min. Turndown)	
		Expander	Compressor	Expander	Compressor	Expander	Compressor
Flow Rate	lb/hr	27,425	27,425	16,604	18,827	9,527	15,548
Pressure	psia	750	145	753	140	753	175
Temperature	F	2.0	76.1	2.0	80.7	2.0	92.4
Molecular Weight	-	16.8	16.8	16.5	16.5	16.5	16.5
Discharge Condition							
Pressure	psia	150	241	149	210	184	210
Temperature	F	-143	164	-134	152	-100	124
Brake Power	HP	520	510	292	285	107	104
Speed	RPM	69000		61100		40600	
Isentropic / Polytropic Efficiency	%	82	72	74	71	53	71
vIGV Position	%	80	-	51	-	29	-



Port Allen - Commissioning

Commissioned December 2017

Setbacks

- Liquid freezing in refrigeration loop
- Expander Compressor Vibration

Currently producing 10k to 30k gallons per day





Questions