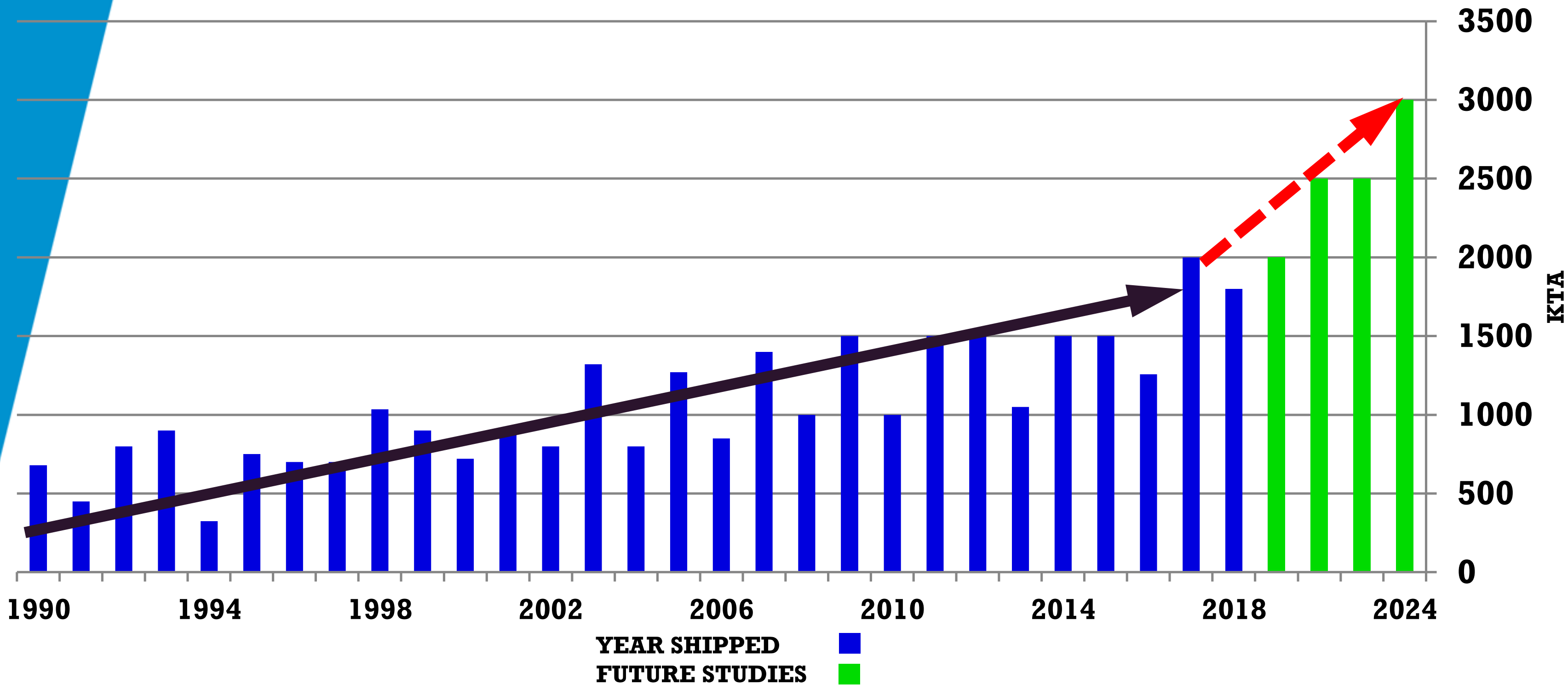
Ethylene Middle East Technology Conference
EMET CONFERENCE

Reducing Costs With the Application of High Flow Coefficient Impellers in the Main Compressors of Ethylene Plants

Shane Harvey, P.Eng – Manager of Application Engineering; Elliott Group

1500KTA CGC String on Test

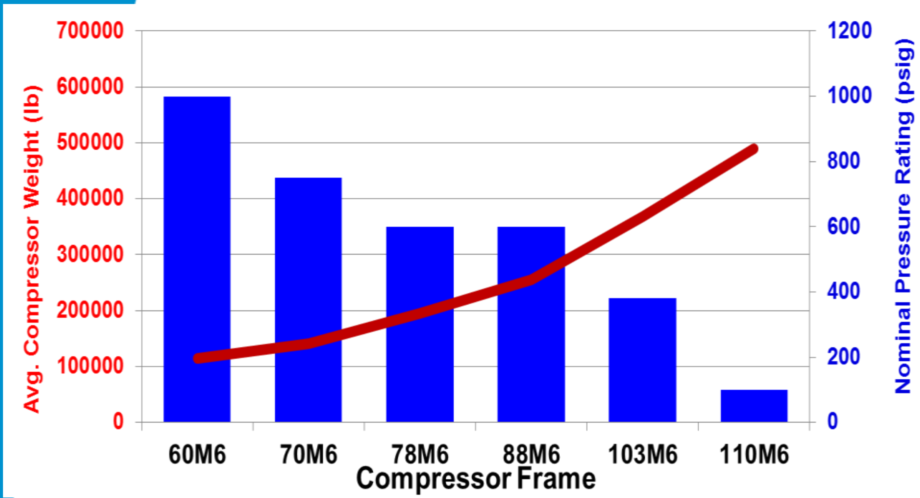
Ethylene Capacity Trend



The Problem:

If the industry continues to simply increase plant capacities and CGC inlet volume flows expecting to increase the scale of the compressors; economies of scale will disappear.

Challenges of Larger Frames



Solution:

Increase the flow capacity of the current frame size compressors.

- Adopting higher flow coefficient stages
- Applying larger nozzles onto the frame size
- Reducing stage spacing of existing stages

Ethylene Middle East Technology Conference

Compressor Flow Coefficient

$$\Phi = \frac{700Q}{Nd^3}$$

Φ = Flow Coefficient
Q = Flow in CFM [ft^3/min]
N = RPM [1/min]
d = Impeller Diameter [ft]

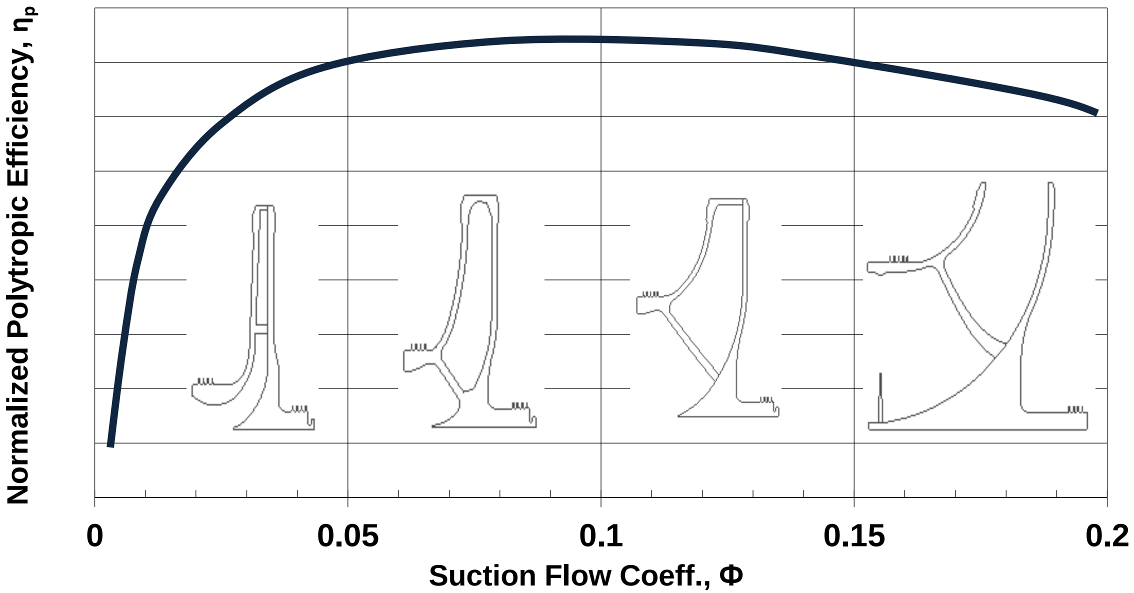
Flow Rate divided by Speed and Diameter^3

Sometimes:

$$\Phi = \frac{Q}{DU}$$

Φ = Flow Coefficient Q = Inlet Flow [m^3/s]
D = Impeller Diameter [m] U= Tip Speed [m/s]

Radial Flow Centrifugal Stage



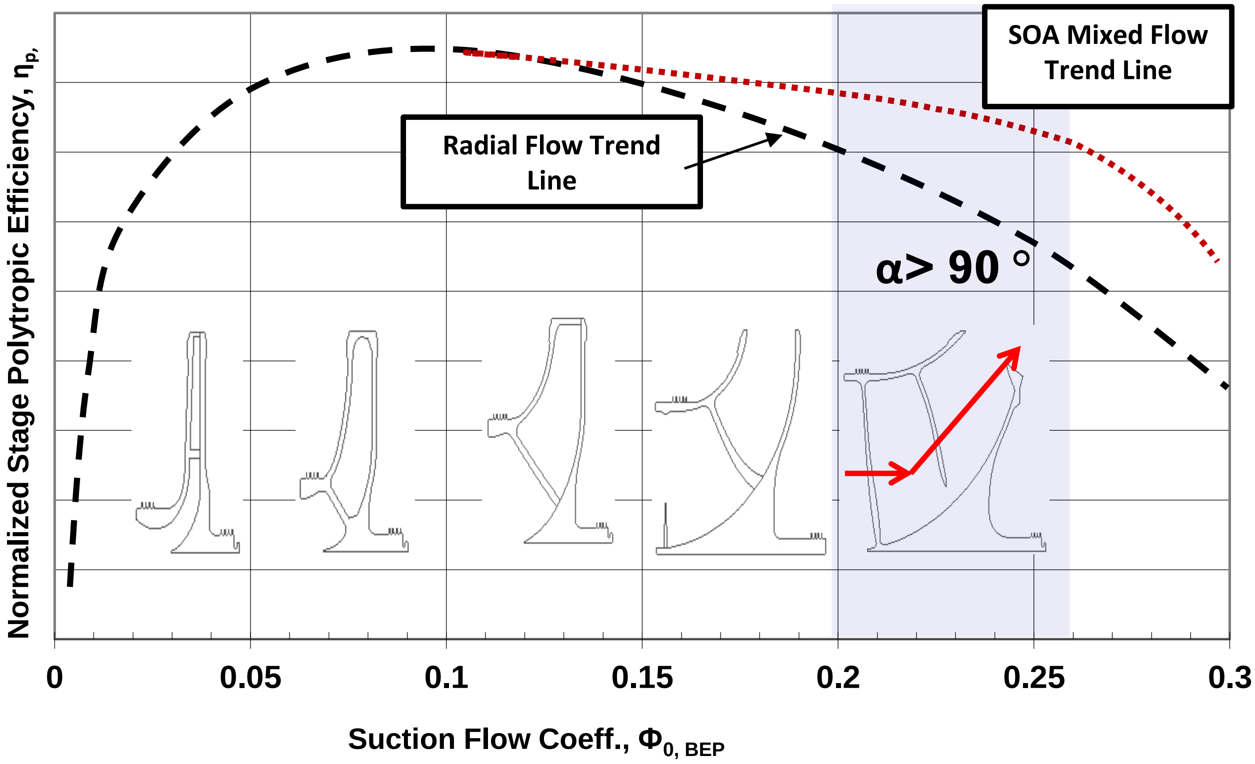
Characteristics:

Exit flow angle α=90°

Peak Efficient ~Φ= 0.1

Practical Limits ~Φ= 0.2

Mixed Flow Centrifugal stage



Characteristics:

Exit flow angle α>90°

Maintains Efficiency above radial well beyond 0.25

Practical Limits ~Φ= 0.3

State of the Art

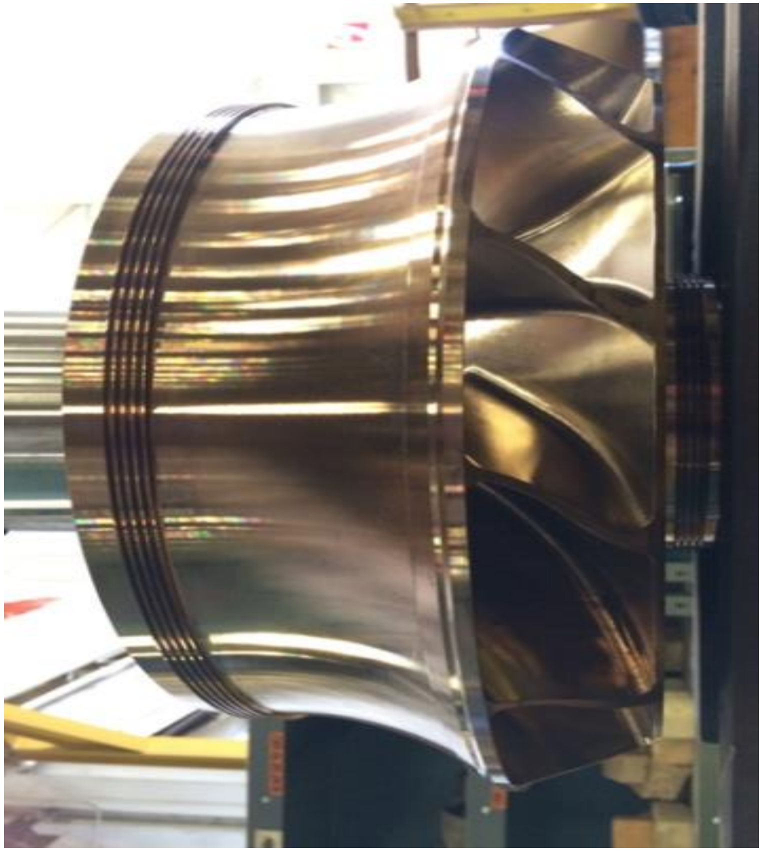
Second Generation Mixed Flow Stage

Optimum flow path sizing and aerodynamic throat area control using splitters.

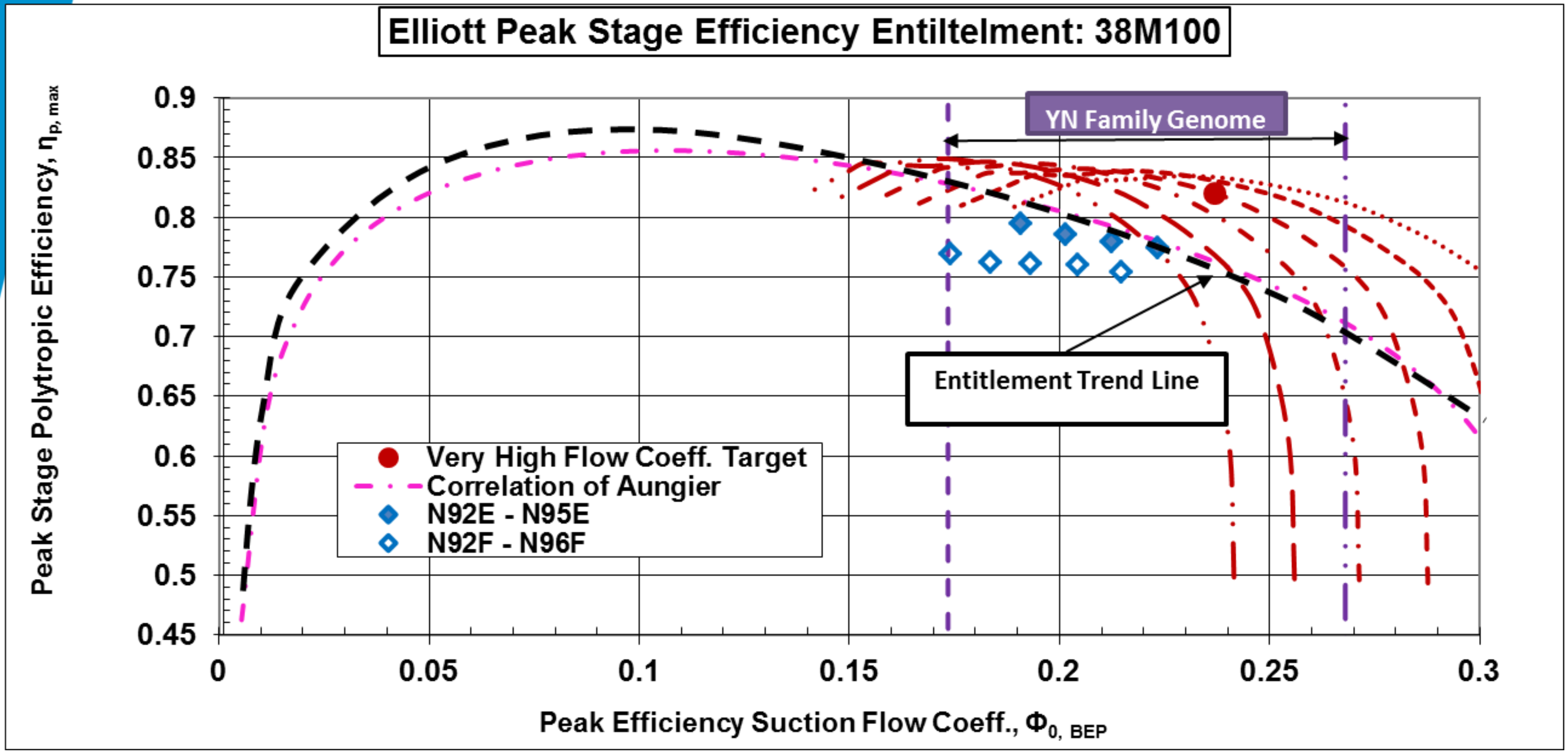
First Generation Mixed Flow Stage

State of the Art

Second Generation Mixed Flow Stage



Built and Tested



Ethylene Middle East Technology Conference

EMET CONFERENCE

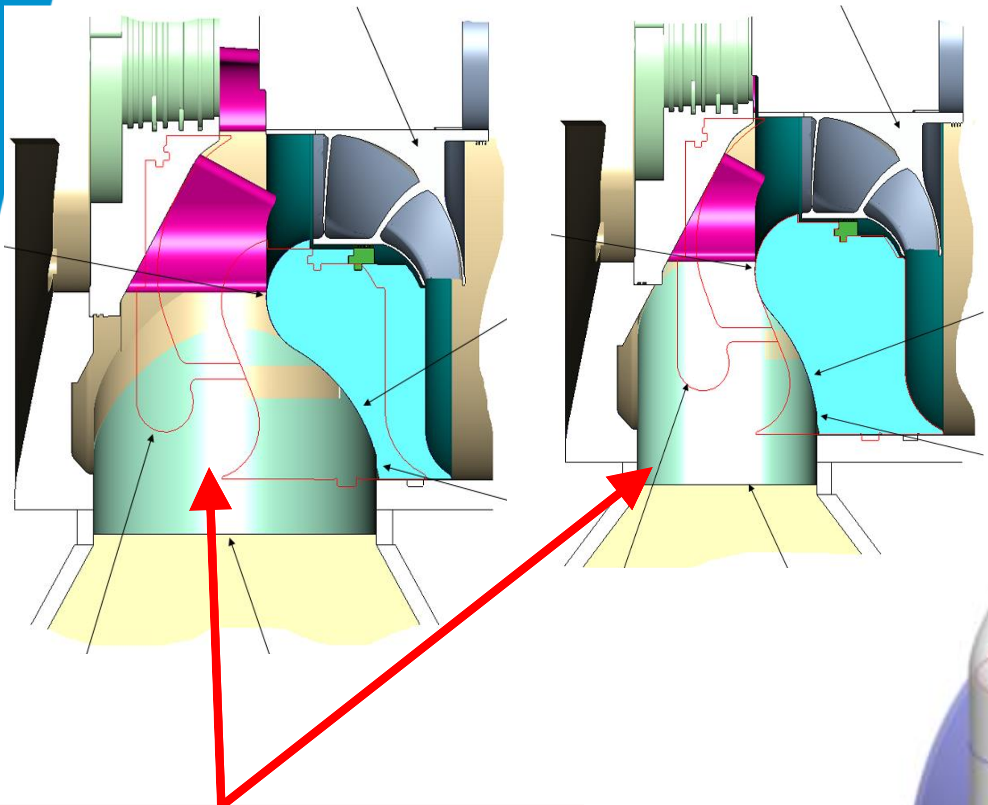
Increased nozzle sizes

Larger nozzles sizes across all frame sizes

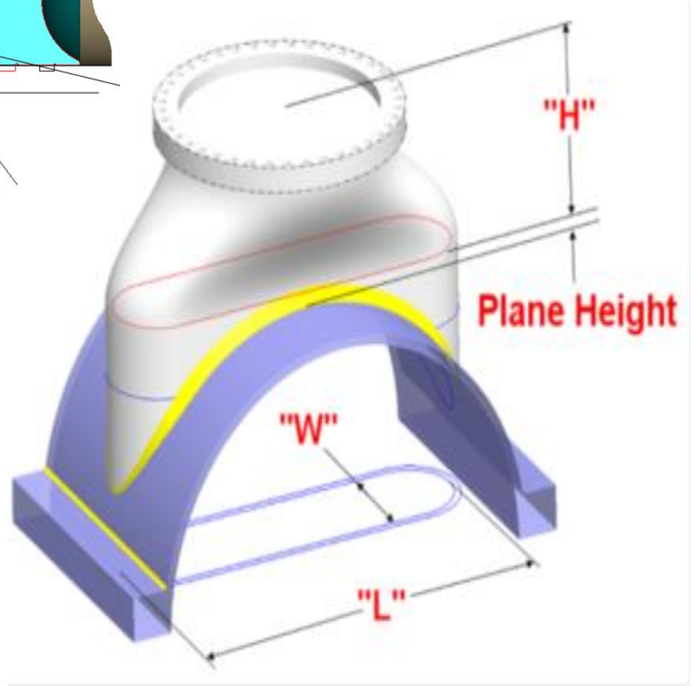
Increases the flow capacity of the frame while improving bearing span

Frame	Previous max inlet	Revised max inlet size	Previous max dsch	Revised max dsch size
	inches	inches	inches	inches
56	36	42	24	30
60	42	48	36	36
70	48	60	30	36
78	54	66	36	42
88	66	78	42	48
103	72	90	54	60
110	84	102	54	66

High Flow Axial Compact Nozzles



Similitude of Required Aeropath Preserved



Case Study of a real 1500KTA plant

Comparison of: Sections 1,2 and 3 of the CGC

2011 design: Sec 1 88MD3-3 – Sec 2 88M4I

Compressor Rated Point: ~58MW @ ~3600rpm

88MD3-3 Sec1: 2x66” Inlets, 66” Discharge

88M4I Sec2/3: 60”/42” Inlets, 42”/36” Discharge

High Flow Coefficient Selection

78MD3-3 – 78M4I

Compressor Rated Point: 58MW @ **4300**rpm

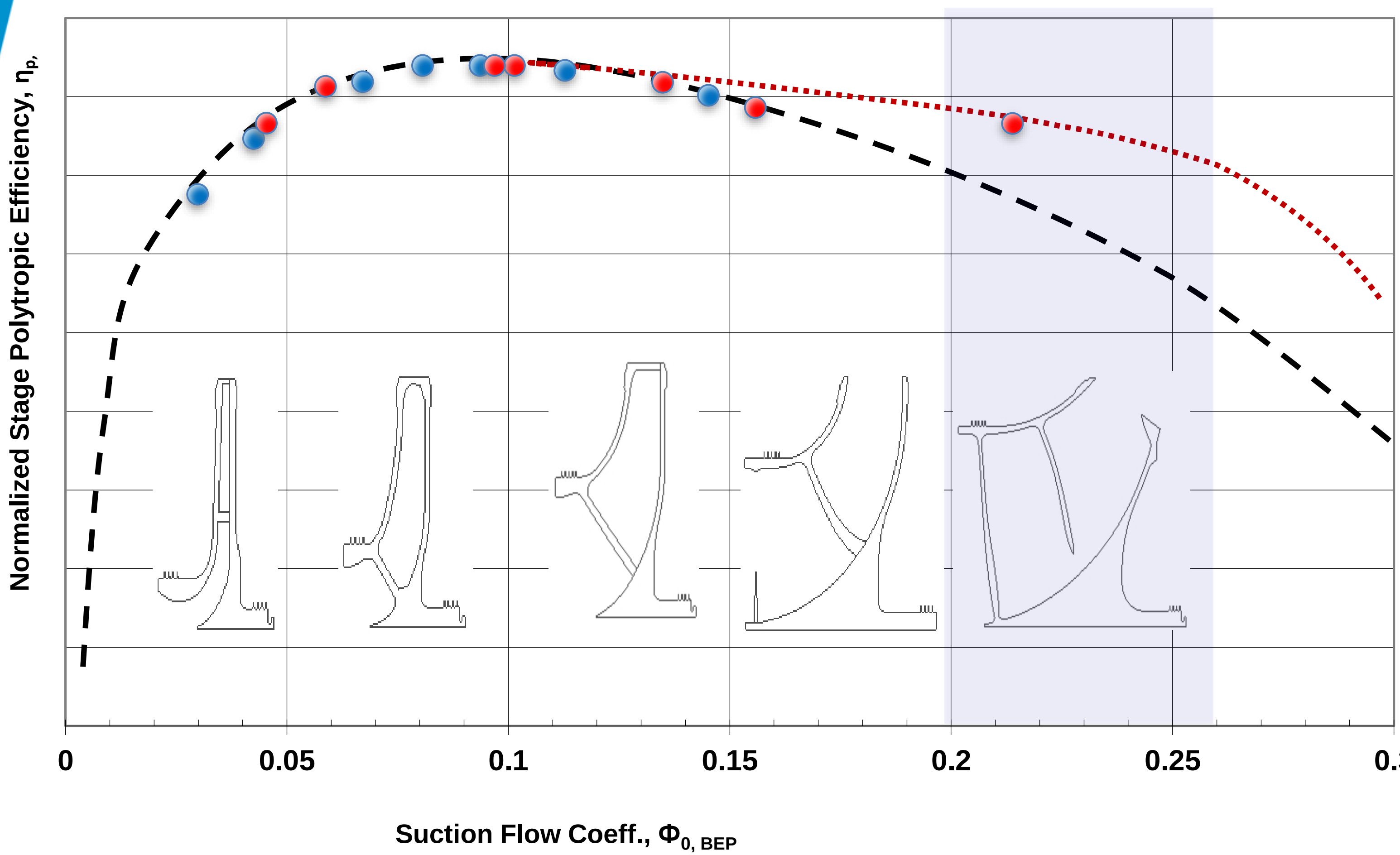
78MD3-3 Sec1: 2 x 66” Inlets, 66” Discharge

78M4I Sec2/3: 60”/42” Inlets 42”/36” Discharge

Smaller Frames:

Casing	First Stage Flow Co Φ	Bearing Span (m)	Rotor Weight (kg)	Unit Weight (kg)
88MD3-3	0.146	5.4	12,000	188,000
78MD3-3	0.214	4.8	9,000	145,000
Delta:	+46.5%	-12%	-25%	**-43,000 -23%**
88M4I	0.0915 & 0.0431	4.4	11,500	168,000
78M4I	0.1351 & 0.0593	4.2	8,600	125,000
Delta:	+48% & +35%	-5%	-25%	**-43,000 -26%**

Overall Compressor Efficiently impact



Ethylene Middle East Technology Conference
EMET CONFERENCE

The Future

The application of high flow coefficient staging is already being done.

This is not limited to 2000+ KTA plants. But also reducing the cost, weight and footprint of plants or all sizes.

Owners, operators, process licensors, EPCs and the equipment OEM need to work together to meet the challenges of the future.

Questions?