Ethylene Middle East Technology Conference

EMET CONFERENCE

TechnipFMC's SFT® Radiant Coil Technology

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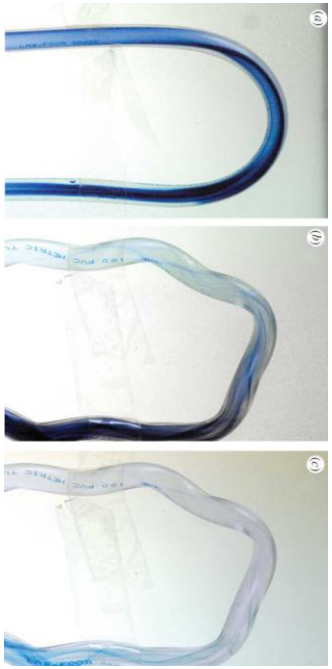
Swirl Flow Tube®

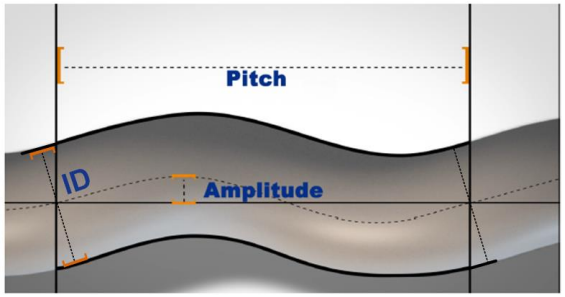


* Veryan Medical Limited: BioMimics 3DTM

What is the connection?

An Overview

- First application in medical field
- 2010: TechnipFMC acquires IP rights for Cracking Coil application



Geometry defined by:

ID	= Inside diameter
Pitch	= Helix Pitch
Amplitude	= Helix Amplitude

Helical tubes of different amplitudes and pitches with line of sight through the helical tubes

* Veryan Medical Limited: BioMimics 3DTM

Benefits

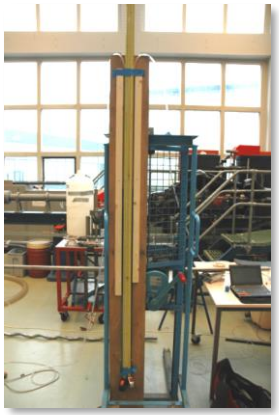
- **Increased heat transfer with low pressure drop penalty.**
- **Higher heat transfer will bring amongst others:**
  - Higher capacity
  - Longer run length
  - Higher selectivity
- **The technology is suitable for revamping of furnaces or new installations.**

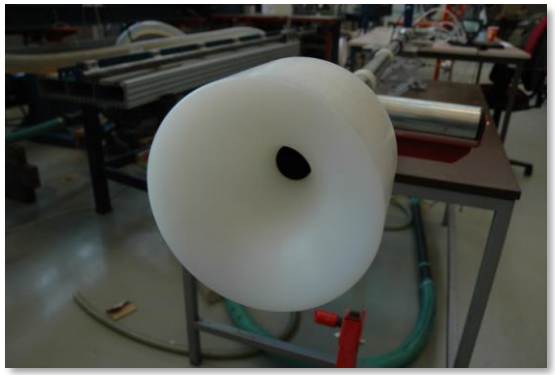
Protocol to first application

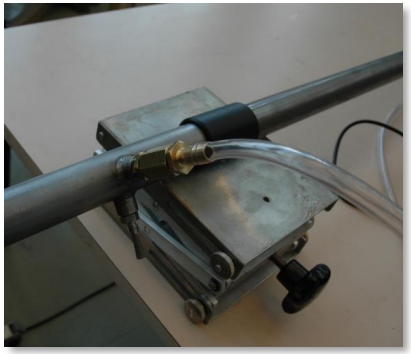
- **Computer simulations**
- **Experimental validation**
- **Pilot scale**
- **Prototype manufacturing**
- **First application**

SFT CFD Model Validation

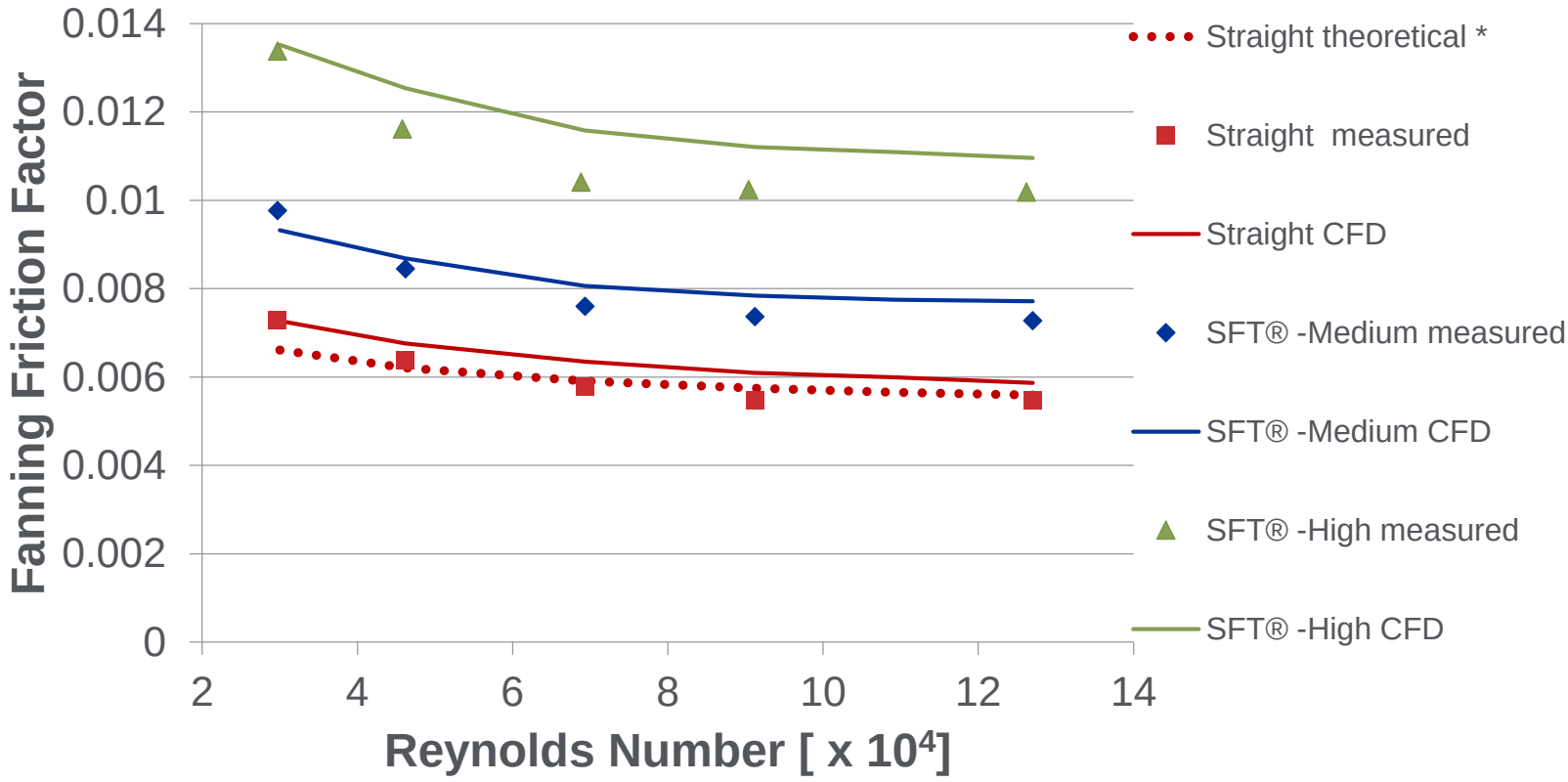
Pressure Drop Validation







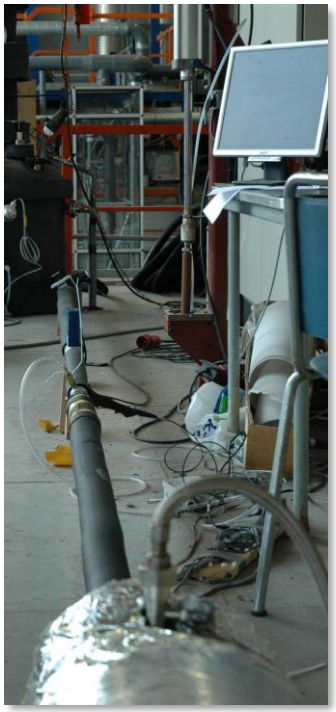
Pressure Drop Validation



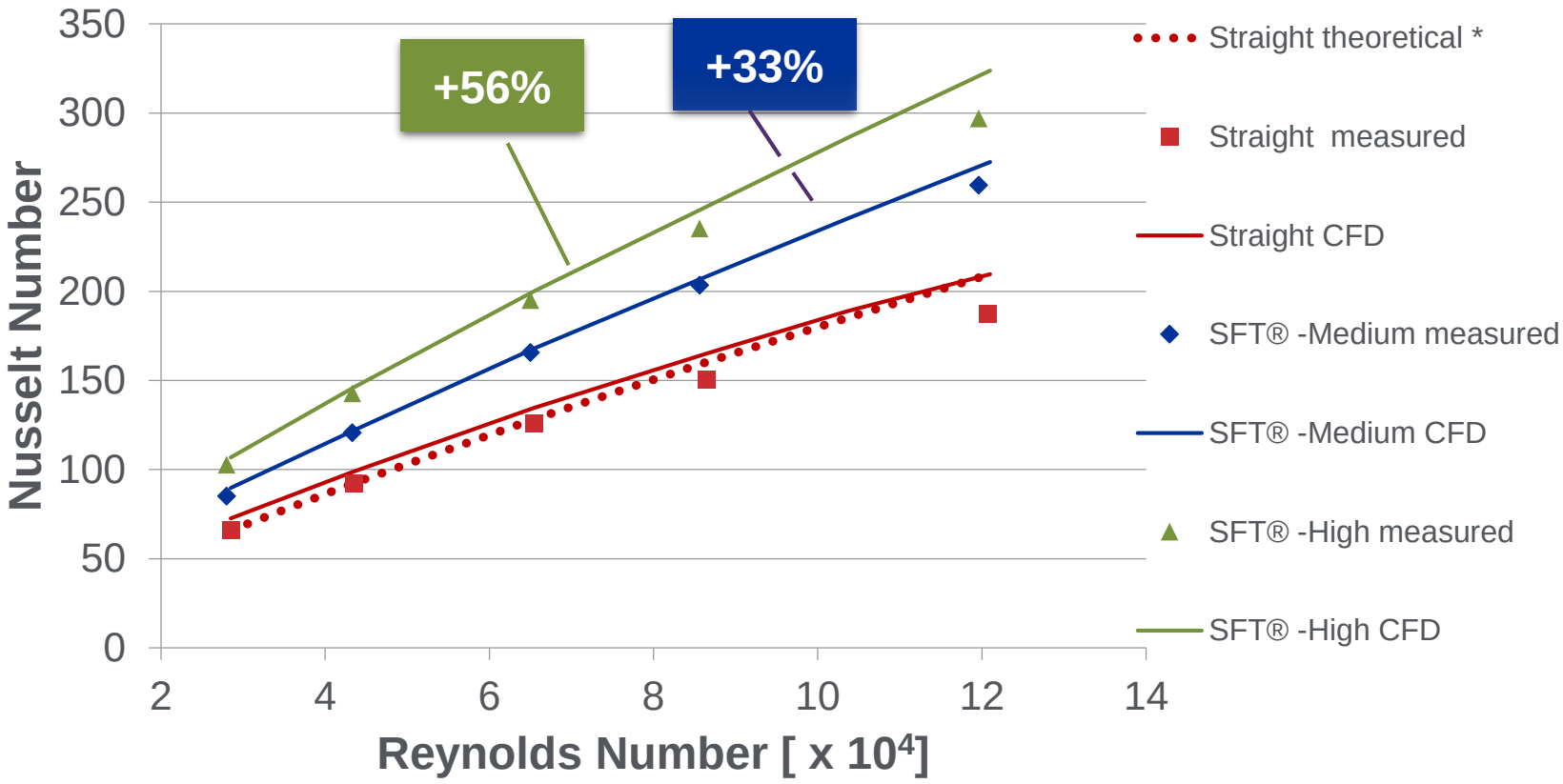
→ CFD pressure drop model validated

* Chen equation at 34µm roughness

Heat Transfer Validation



Heat Transfer Validation



→ CFD heat transfer model validated

* As per VDI Wärme Atlas

Pilot Plant Performance

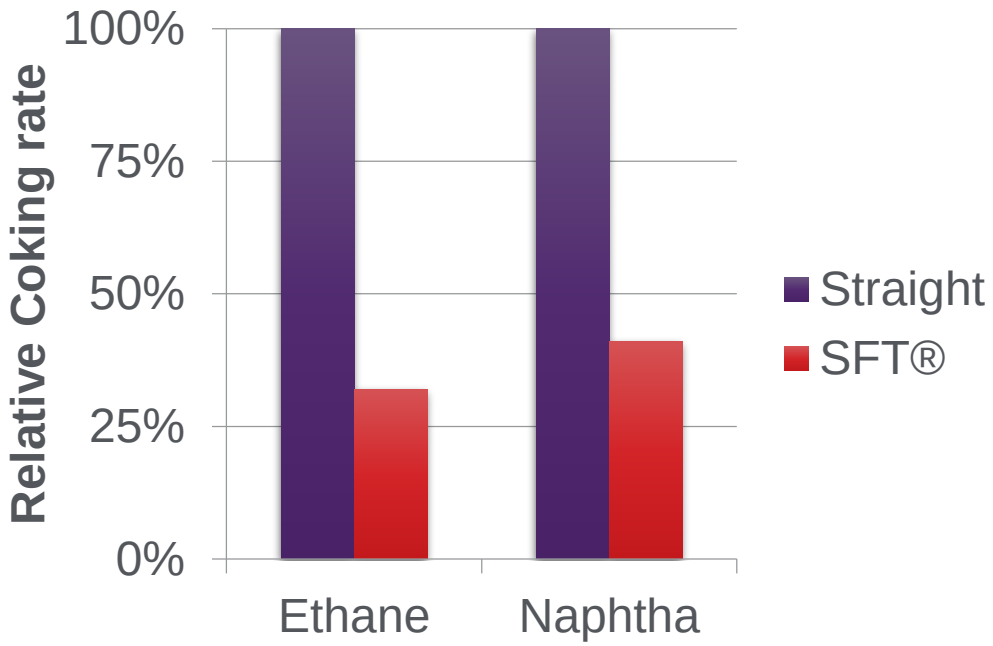
Coking Validation Pilot Plant Test at University of Ghent

- **Validate coking behavior of the SFT coils**
- **Two coil types**
  - Straight
  - SFT
- **Tested with ethane and naphtha feed**

Pilot Plant Test: Relative Coking Rates

→ Substantially lower coking rates observed due to

- **Lower wall temperature**
- **Increased turbulence**



Application Options of SFT

Performance

IMPROVEMENT OPTIONS	
Longer run length	At same severity and feed rate
Higher capacity	At same severity and run length
Higher selectivity	At same feed flow rate and run length

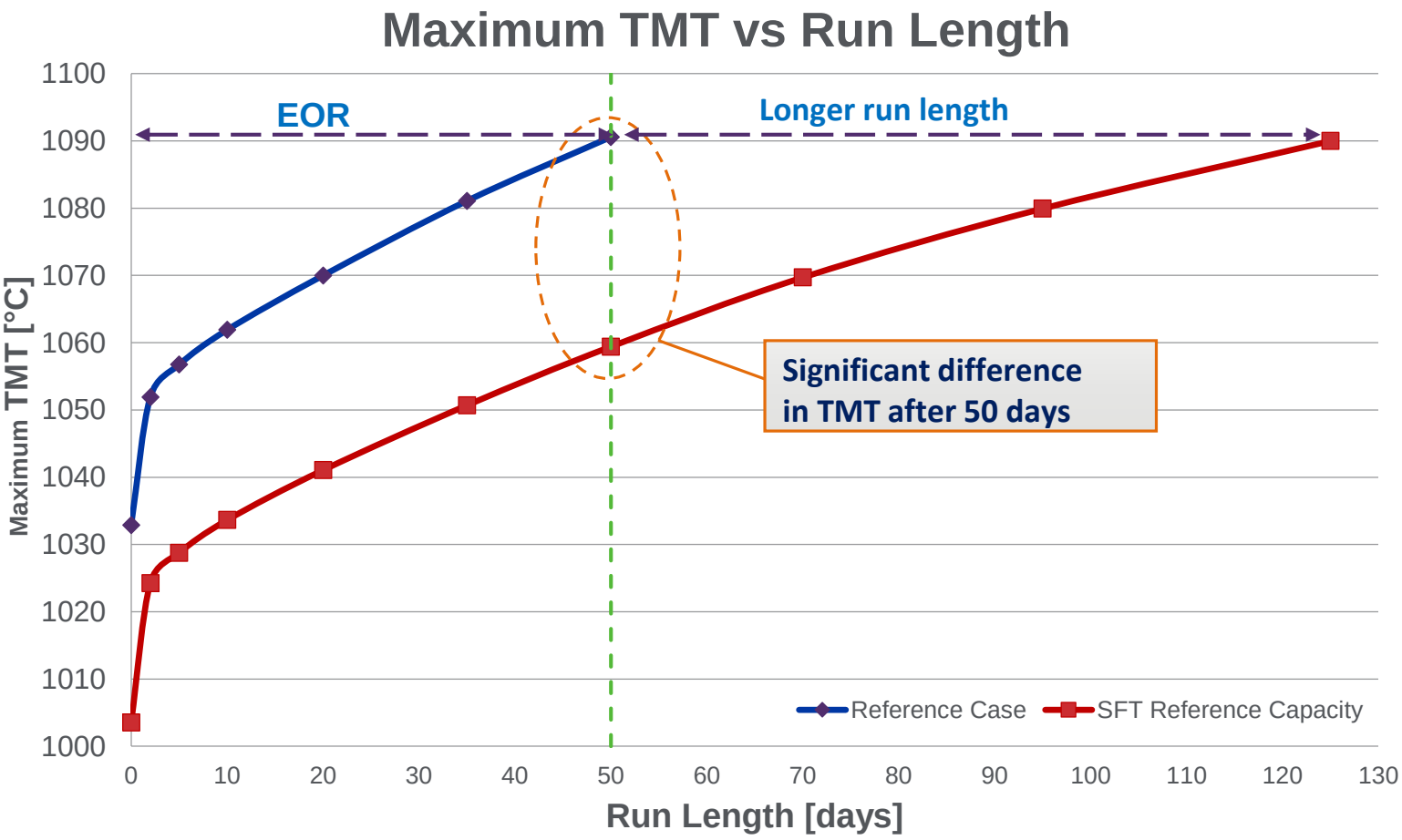
Longer Run Length Case Study

- **Yields and pressure drop are hardly affected**
- **Lower TMT after 50 days**
- **Longer run length at same capacity**

Longer Run Length	**BARE**		**SFT®**	
	SOR	50 days	SOR	50 days
Base Naphtha feed rate, t/h	40.5		40.5	
DS	0.5		0.5	
Max. TMT, °C	1033	**1091**	1004	**1059**
Coil ΔP, bar	0.47	**1.04**	0.59	**1.02**
Yields, wt.% (dry)				
Ethylene	35.14	34.32	34.99	34.31
Propylene	13.7	13.38	13.64	13.38
Ultimate Ethylene production, kta *	130.8	**128.8**	130.4	**128.7**
EOR @ TMT =1091 °C		**50 days**		**>120 days**

*Based on 8400 operating hours per year

Longer Run Length Case Study



Higher Capacity Case Study

Higher Capacity	SFT®	BARE
	SOR	SOR
Base Naphtha feed rate, t/h	**47.1**	**40.5**
DS	0.5	0.5
Max. TMT, °C	1022	1033
Coil ΔP, bar	0.75	0.47
Yields, wt.% (dry)		
Ethylene	34.99	35.14
Propylene	13.65	13.7
Ultimate Ethylene production, kta *	152.0	130.8
Ethylene production increase	**16%**	base
EOR @ TMT =1091 °C	50 days	50 days

→ 16% capacity increase

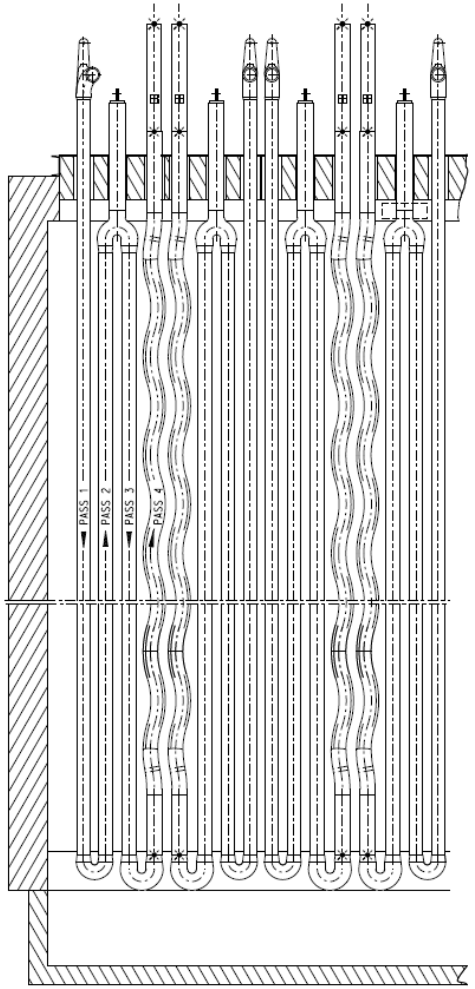
*Based on 8400 operating hours per year

SFT Application for Higher Capacity

SMK™ Gas Cracker

Design Parameters

- **Application of SFT for capacity increase**
- **Gas feedstock**
- **TechnipFMC's proprietary SMK™ radiant coil technology**
- **Outlet leg 35Cr45NiNb-MA material**
- **ID of 100mm**



Engineering

- **Executed adequacy check of desired capacity increase**
- **Design of the SFT using TechnipFMC's standard engineering practices and tools, such as SPYRO® Suite 7**
- **Outcome to obtain capacity increase :**
  - Re-rating of some convection sections
  - 4th leg of SMK™ coil equipped with SFT-H

Fabrication

- **TechnipFMC has developed its own bending technology and tooling**
- **Centrifugal casted tubes are shaped into helical tubes by induction bending**
- **Quality control according ASME/ASTM standards (thinning, ovality, DPI, material properties: creep, tensile, composition)**
- **TechnipFMC developed procedures to safe guard quality during bending, assembly and installation.**

Assembly

- **SFT radiant coil pass is an assembly of helical tubes in stead of straight tubes**
- **TechnipFMC has successfully completed manufacturing 200 SFT® sections**
- **Assembly of 44 outlet legs (4th pass) for world's largest SMK™ coil**

Installation/Performance

- **SFT installation similar to standard recoiling**
- **No modification required to spring hanger system**
- **SFT tubes have been installed in May 2017**
- **Results are promising:**
  - more than double of Run length
  - Performing better than expected
  - Realized anticipated capacity increase

Conclusions

Conclusion

- **Successfully validated**
- **Reduced coking behavior**
- **SFT is superior to alternative technologies**
- **Better heat transfer can be exploited to increase:**
  - Run length
  - Capacity
- **Ready for application:**
  - Revamps as well as new furnaces
  - First implementation in operation
  - Second and third fabricated
  - Fourth application in fabrication

→ **SFT is the best heat transfer enhancement technology available**