

Torad Spool Compressor

2012

Torad Spool Machine



*“Spool Technology combines the positive sealing of a **piston compressor** with the reliability of a **screw** or **scroll compressor**”*





The Torad Technology

Spool Machine Features

- Simple design
- Compact size
- Scalable design
- High displacement density
- Variable speed operation
- Easy access to intermediate pressures
- Open, semi-hermetic, hermetic configurations





Spool Machine Benefits

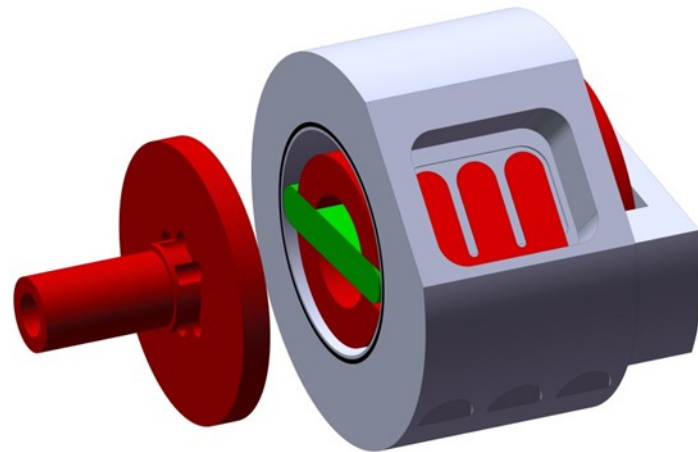
- Lower cost
- High efficiency level over wide operating range
- Tolerant of liquid flood back
- High pressure ratios possible
- Simple oil management system
- Applicable to multiple markets
- Wide range of applications

Compressor Technology Challenges for HVAC/R Industry



- Design Complexity
- Scalability
- Size/Weight
- Cost
- Flexibility
- Design Options
- Refrigerants
- Reliability

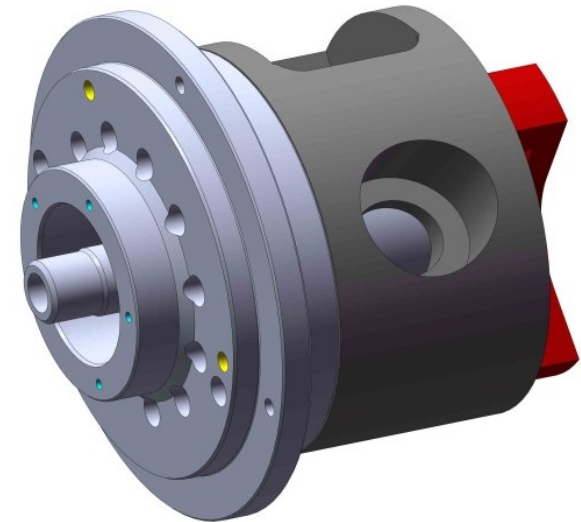
How Torad is Addressing These Challenges



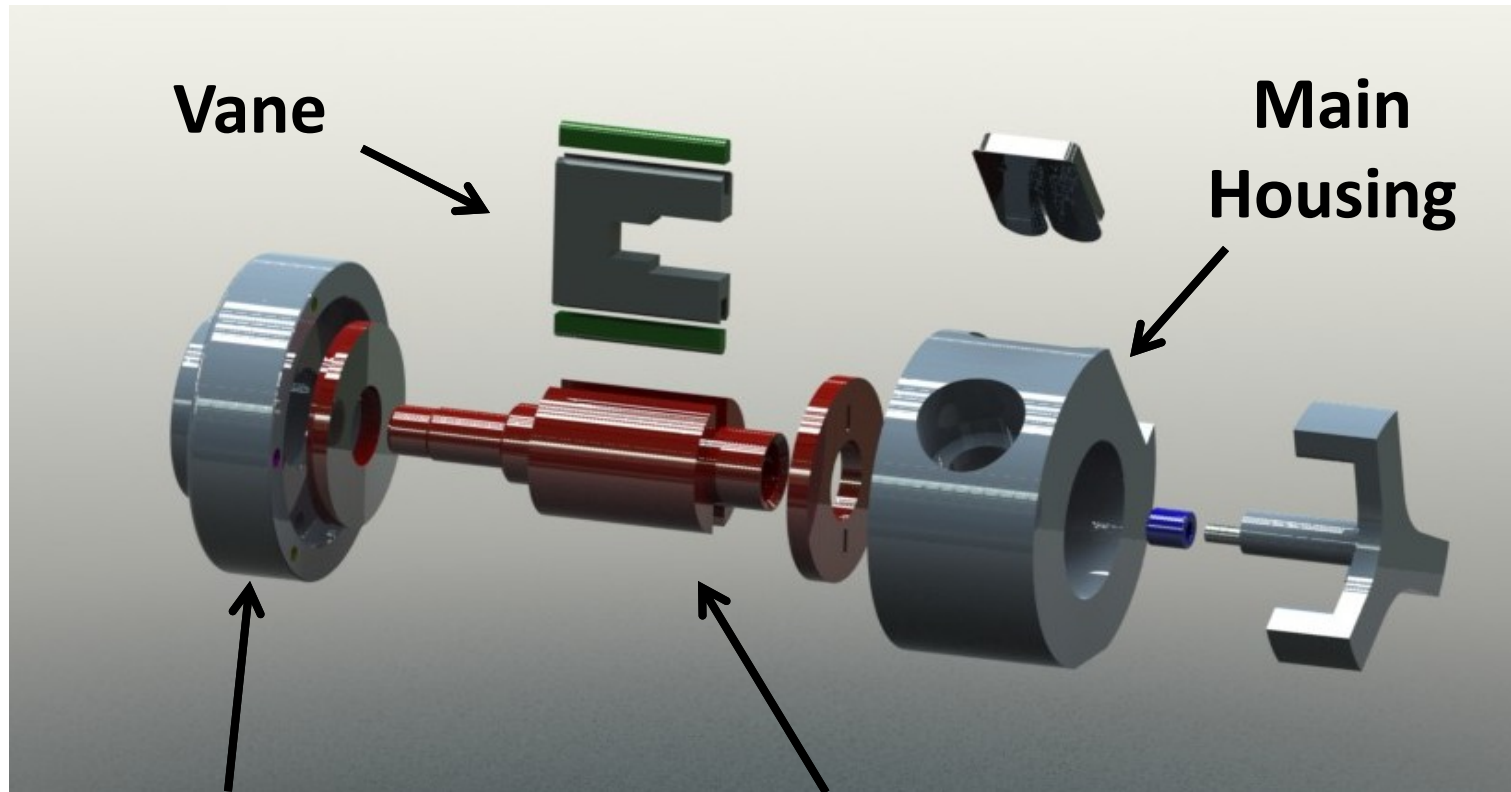
Spool Design



- Compression Cycle
 - Positive displacement design
 - No Internal Compression Ratio
 - Two compression cycles per rotation
 - Positive sealing design attributes



Design – 4 Major Components



**Bearing
Housing**

**Rotor
Assembly**

**Main
Housing**

Vane



Scalability

- Scalability in Size
 - 5 - 300HP
- Why does it scale?
 - Displacement volume grows faster than the torque loss areas
- Benefits
 - Reduces raw material per CFM of displacement
 - Lower processing cost per CFM
 - Improved performance
 - Ability to cover a large range of sizes and applications



Size/Weight

- Comparison

Spool vs. Scroll			
	40 Ton Spool	30 Ton Scroll	Difference
Height	24"	30"	-20%
Diameter	10"	13"	-25%
Volume	1,884 in ³	3,892 in ³	-52%
Weight	280lbs	360lbs	-25%

Spool vs. Screw			
	80 Ton Spool	80 Ton Screw	Difference
Height	30"	43"	-30%
Diameter	10"	15"	-40%
Volume	2,356 in ³	7600 in ³	-70%
Weight	360lbs	715lbs	-50%



Applied Cost Benefits

- Less cost for freight due to less weight and more compact
- Scalability reduces manufacturing costs
- Improved form factor vs. large scroll vertical designs
- Ability to apply compressor cost savings towards system efficiency enhancements
- Improved field service



Flexibility

- Applications
 - Industrial
 - Commercial
 - Light Commercial
 - Air-Conditioning
 - Refrigeration
 - Industrial Refrigeration
 - Alternate Gas Applications

Compressor Technology Comparison



Attributes	Spool	Screw	Scroll	Spool Compressor Advantages
Design Simplicity	★★★★★	★★	★★★	4 main components, 1 moving assembly
Ease of Production	★★★★★	★★	★★	Simple design allows for no tight tolerances and low part count
Scalability	★★★★★	★★★	★★	Sizes from 5HP to 300HP
Size	★★★★★	★★	★★★	30 ton Spool is 50% < 30 ton scroll 80 ton Spool is 65% < 80 ton screw
Weight	★★★★★	★★	★★★	30 ton Spool is 30% < 30 ton scroll 80 ton Spool is 50% < 80 ton screw
Cost Effectiveness	★★★★★	★★★	★★★	Estimated 25%+ cost reduction on the compressor side (excludes motor end)
Energy Efficiency	★★★★★	★★★★★	★★★★★	Equal to and > market efficiencies
Flexibility	★★★★★	★★★★★	★★★	Able to serve multiple markets
Design Options	★★★★★	★★★	★★★	Ideal for variable speed operation and easy access for liquid/vapor injection
Sound	★★★★★	★★★★★	★★★★★	Comparable market levels
Refrigerants	★★★★★	★★★★★	★★★	HFCs, Propane, CO ₂ (not single stage)
Reliability	★★★★★	★★★	★★★	Robust design and tolerant to liquid floodback. No internal compression ratio.



Summary

- Why consider Spool Compressor Technology?
 - Simple design
 - Low Cost
 - Scalable
 - High Displacement Density

“The Next Generation of Refrigerant Compressor Technology”