Making Something From Nothing:
"The Green Machine Turns Waste and Geothermal Heat Into Power"

GulfCoast GREEN ENERGY

Waste Heat
Making Something From Nothing

There is over **9 million megawatts** of free energy

That's 18,000 - 500 MW Coal fired plants! Energy for the taking

Assumes global average thermal efficiency of 40% X 14 terawatts total world energy consumption - Dr. Richard Smalley, Rice University, June 23 2003) Nobel prize winner

- **Waste Heat is Bigger than oil, coal, natural gas and nuclear…Combined**
  - –60% of all world energy becomes waste heat

Waste Heat is Zero-Pollution Energy

- It's not only Carbon Neutral it's *Zero* pollution
- It's free
- The fuel's been paid for and consumed

Just 10% = 380,000 megawatts.
At $0.10 per kilowatt-hour

$380 billion/year
free and non-polluting energy!

That's equivalent to
2500
$150 Million/year companies!!!
Power 750,000,000 Homes

This is a local pollution solution

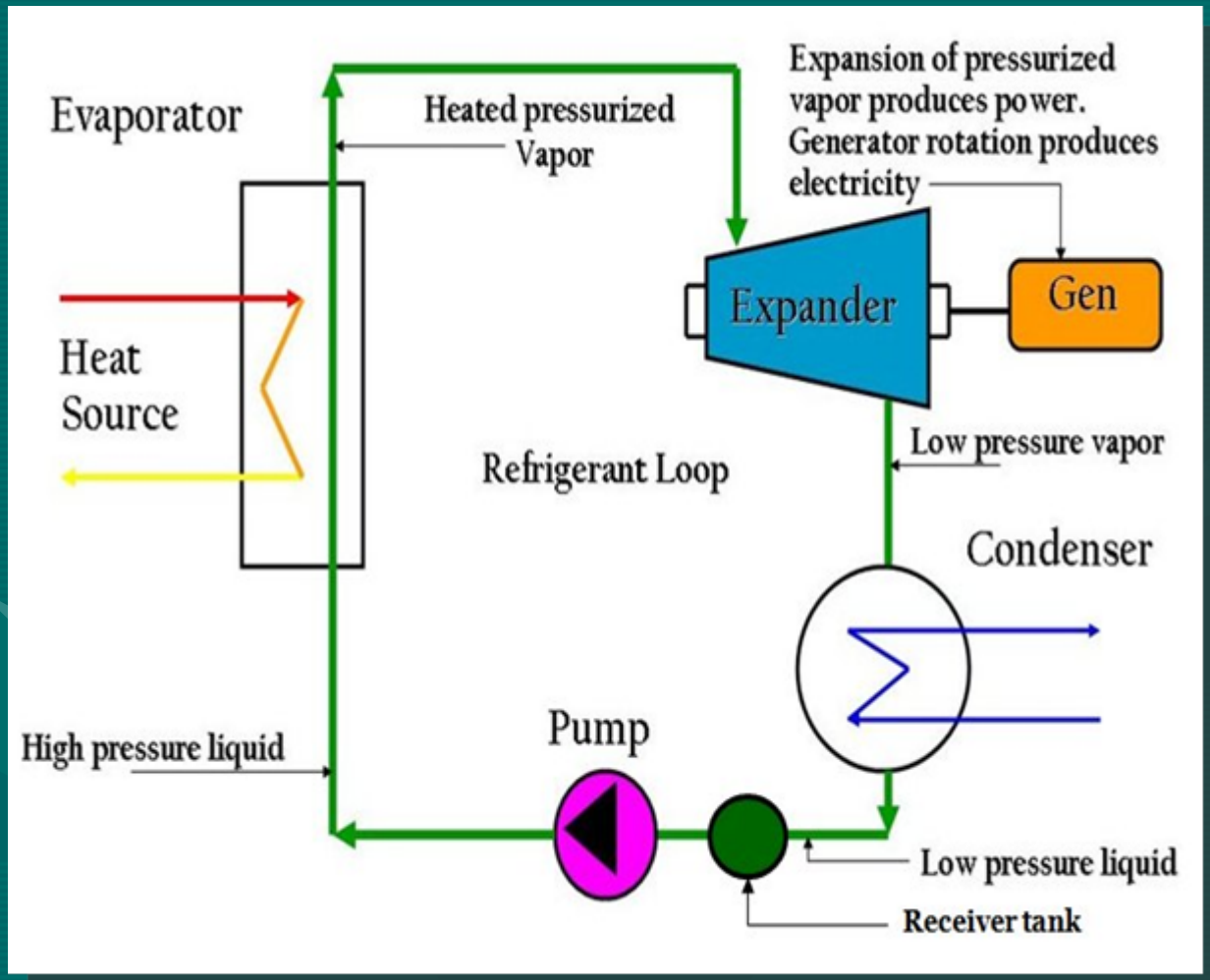
ElectraTherm's Patented Green Machine

- ElectraTherm has developed a proprietary heat recovery system that is based on an Organic Rankine Cycle
- This cycle utilizes a refrigerant as the working fluid
- This enables them to economically convert relatively small heat sources into power
- It is called the Green Machine

Gulf Coast GREEN ENERGY Teams Up With ElectraTherm, Inc.

- Representative in Texas/other states for sales, installation and service
- In 2007 GCGE installed first commercial ElectraTherm Green Machine in U.S. at Southern Methodist University (SMU)
- Strong technical team to ensure customer service before/after the sale

Here's how they work:



Surplus heat captured by the evaporator is used to "boil" the working fluid into a vapor.

Under pressure, the vapor is forced through the screw expander, turning it to spin an electric generator.

The vapor is cooled and condensed back into a liquid in the condenser.

The working fluid liquid refrigerant is pumped to higher pressure and returned to the evaporator to repeat the process.

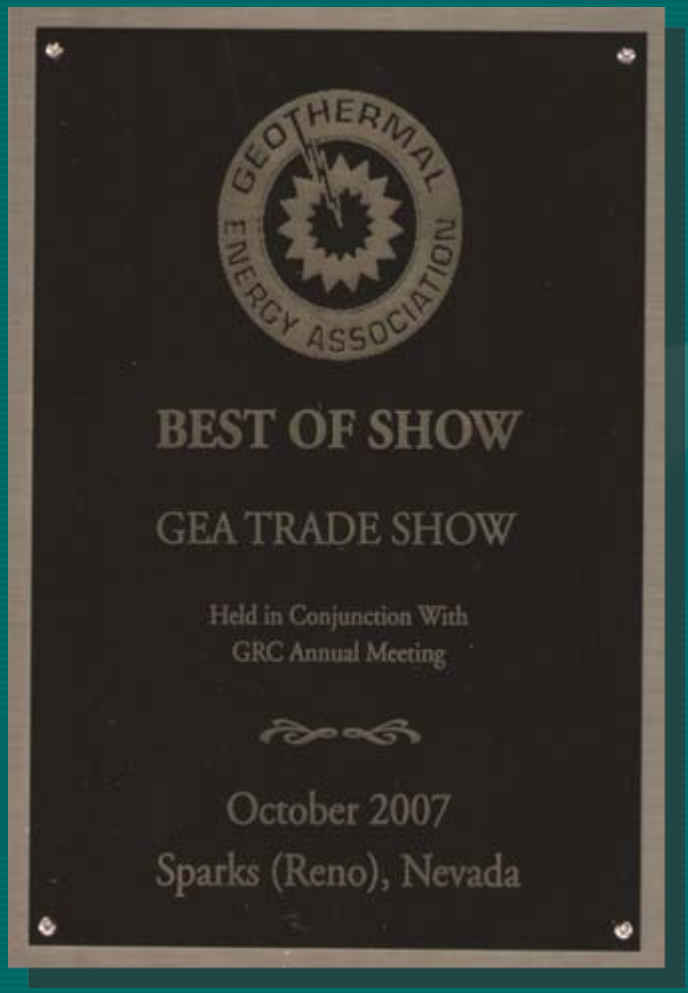
ET Technology
makes electricity
from many heat sources including:

Gulf Coast Green Energy

ET's Products are:

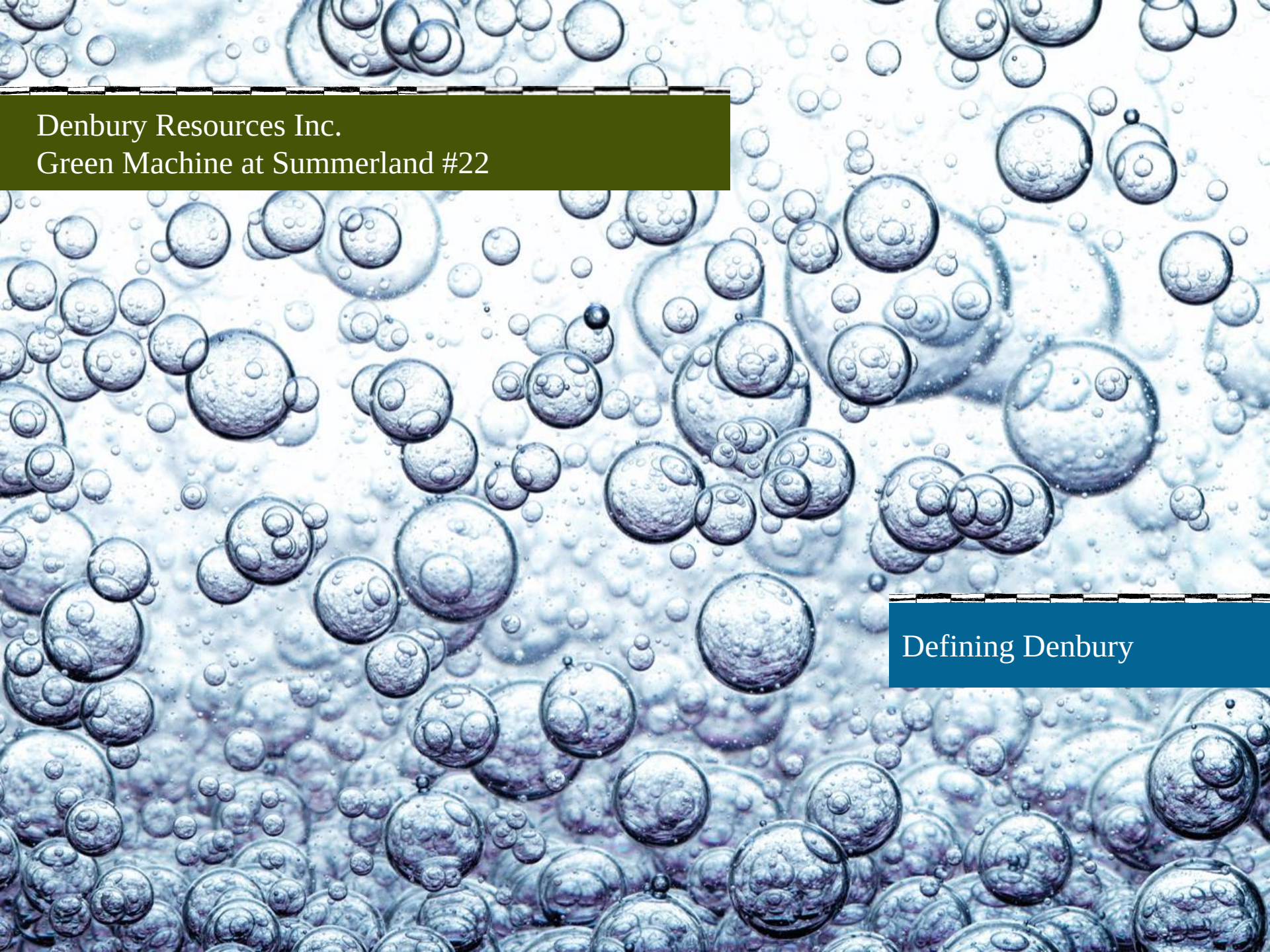
- ✓ innovative
- ✓ economical
- ✓ reliable
- ✓ green
- ✓ available now

POPULAR SCIENCE THE FUTURE NOW BEST OF WHAT'S NEW 08



RFP2008SP001

"Electrical Power Generation from Produced Water: Field Demonstration of Ways to Reduce Operating Costs of Small Producers"



Denbury Resources Inc.
Green Machine at Summerland #22

Defining Denbury

Denbury - Summerland #22

- **GCGE approached Denbury in December 2008 about participation in a study on power generation from high temperature wells.**
- **Summerland well #22 was identified as a suitable candidate for the Green Machine**
- **Summerland field is located in Jones County, Mississippi.**
  - **Well #22 produces from the Wash Fred formation at 9500 ft. under natural water drive.**
  - **The well produces 100 BOPD and 4000 BWPD on down hole ESP artificial lift.**
  - **The surface flowing temperature is 200 degrees F.**
  - **The well is not part of a CO2 flood.**
  - **Based on calculations from GCGE, the Green Machine can produce 30 KW or approximately 25% of the power needs of the ESP pump. About a 3 year payout.**
- **Power at the site is provided by Dixie Electric, a rural power cooperative.**
  - **Connection will be downstream of a primary meter. Offset $0.098/kwh vs. selling at $0.044/kwh.**
  - **Power companies are sensitive about co-generation. Need to protect their system. Requires contract agreements with the power company.**

Summerland #22 Site

#22 Battery. Production Separator

Green Machine Location

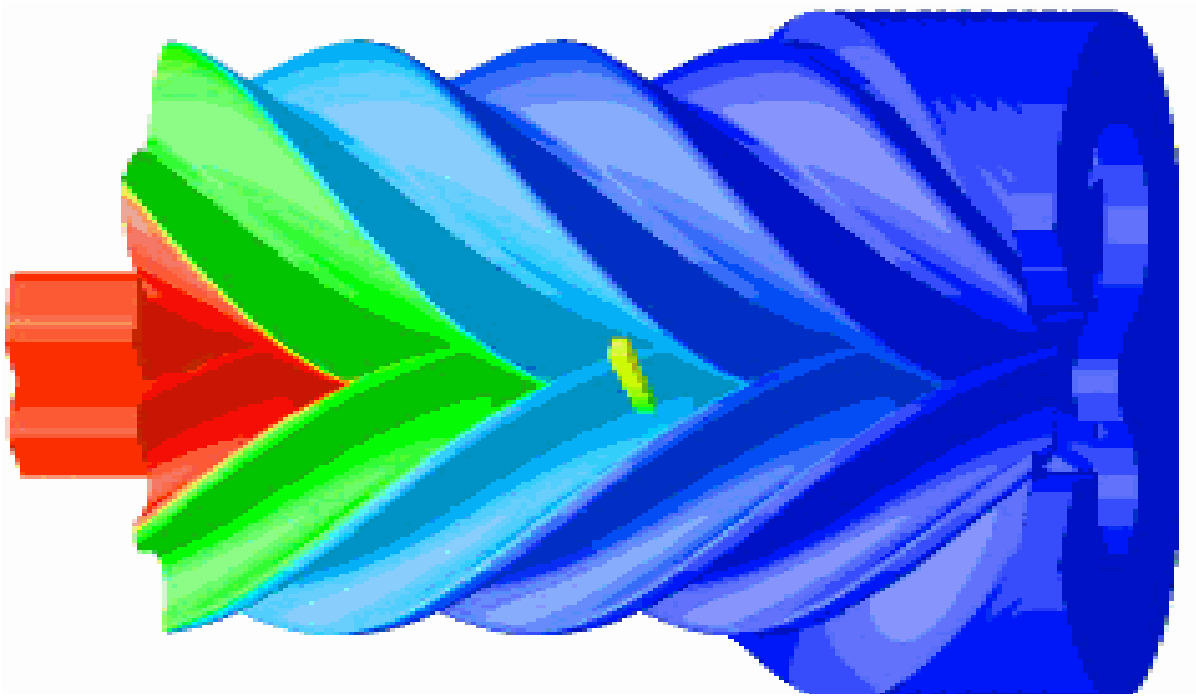
Twin Screw Expanders

An enabling technology…

By
Andrew Oxner

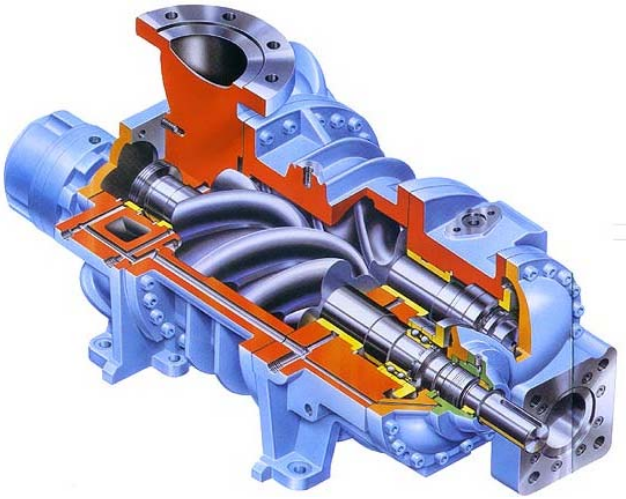
Twin Screw Rotors in a Casing

Twin screw expander



- Trapped volume is initially zero
- Volume of that chamber then increases
- Further rotation then leads to cut off of the chamber
- Trapped volume starts to decrease

Turbo vs. Positive



- Change of momentum imparted to the fluids
- Steady flow of fluids at high velocities

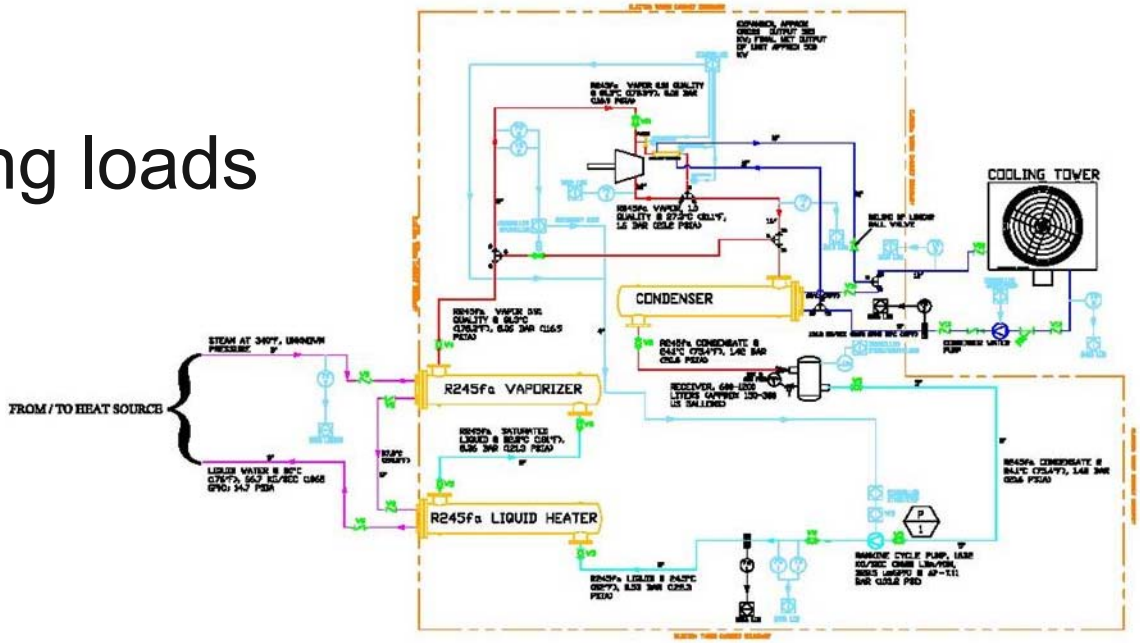
- Admitting a fixed mass of fluid into a working chamber where it is confined and then compressed or expanded and finally discharged

Screw vs. other Displacement

- Moving parts all rotate and hence can run at much higher speeds
- Contact forces within them are low
- Sealing lines of contact which define the boundaries of each cell chamber, decrease in length as the size of the working chamber decreases and the pressure within it rises
- Rolling motion discourages seizure

Expander advantages in small ORCs

- Wet inlet conditions are permissible
- Adiabatic efficiency can be very similar to turbines
- Improved rotor profiles mean greater efficiency
- Lower tip speeds, lower overall speed
- Mass produced
- Efficient with varying loads
- Long service life



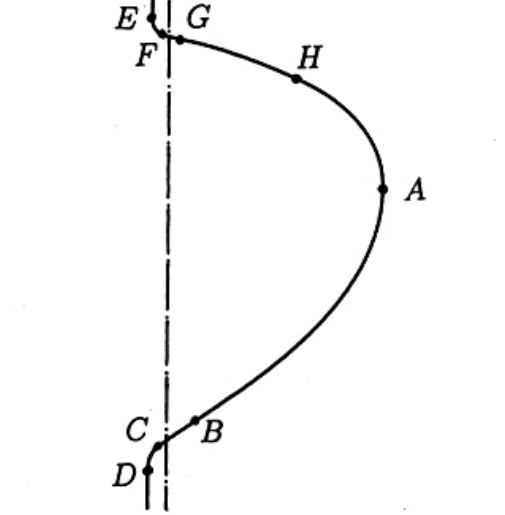
Expander Optimization

- Large flow cross sectional area
- Short sealing line
- Small blow-hole area
- Higher flow and smaller leakage rates both increase the volumetric efficiency
- For low pressure differences, leakage rate will be relatively small and hence the gains achieved by a large cross section area may outweigh the losses associated with a larger blow-hole
- Similar considerations determine the best choice for the number of lobes since fewer lobes imply greater flow area but increased pressure difference between them

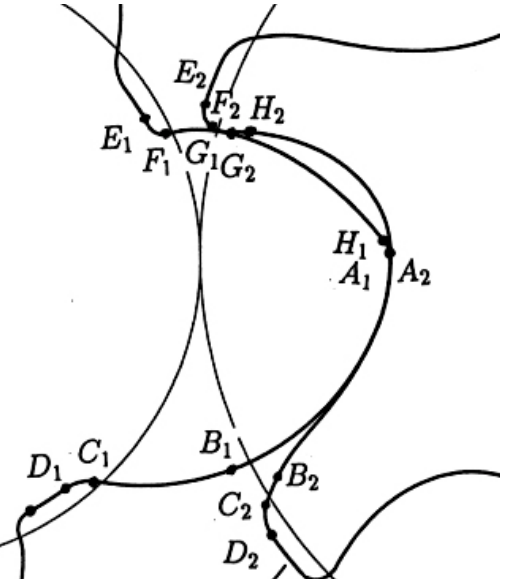
Main/Gate Configuration

- 3/5, dry applications, offers a high gear ratio
- 4/6, for both dry and oil-flooded
- 5 main rotor lobes are suitable for higher compressor pressure ratios
- 4/5, arrangement has emerged as the best combination for oil-flooded applications of moderate pressure ratios, permits the smallest overall dimension for the rotors
- Also, one less lobe in the gate rotor compared with the 4/6 combination can improve the efficiency of rotor manufacturing
- 6/7 for high pressure and large built-in volume ratio refrigeration applications

N Profile and More



E-F Circle
F-G Straight Line
G-H Undercut by the Gate Rotor
H-A Undercut by the Main Rotor
A-B Arc: p=0.43, q=1
B-C Straight Line
C-D Circle
D-E Straight Line



- Full tightness, small blow-hole area, large displacement, short sealing lines, small confined volumes, involute rotor contact and proper gate rotor torque distribution together with high rotor mechanical rigidity
- Design also involves mathematical modeling to determine the optimum rotor size and speed, shape and position of the suction and discharge ports, taking into account of the limitations imposed by bearing and seal selection.
- Goal: Maximize endurance, efficiency, and reliability!

City University London

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