Electric Energy Saving in Building HVAC and Domestic Refrigerators by Vapor Compression Power Regeneration Cycles
COLD

LOW TEMPERATURES

ARTIFICIAL COOLING

IMPROVES THE QUALITY OF THE LIFE OF HUMAN BEINGS
URBAN BUILDINGS

HOUSES, SHOPS, RESTAURANTS & MORE...
INDUSTRIAL BUILDINGS
ELECTRIC WORK CONSUMED FOR COOLING POWER PRODUCTION

- WORLDWIDE: 17%
- INDUSTRIALIZED COUNTRIES: 22%
- DEVELOPING HOT COUNTRIES UP TO: 40%
- WORLDWIDE CO2 LINKED EMISSIONS: 4.5%
- + MILLIONS OF GASOLINE AND DIESEL FUEL LITRES: CARS, TRUCKS, SHIPS, etc.

### COOLING POWER PRODUCTION [GkWh]

- WORLD: 3061
- CHINA: 1029
- ITALY: 75
- USA: 949
- JAPAN: 231
SIMPLE CYCLE

CP = m * efsc
Pel = m * WMCsc
COP = efcs / WMCsc
SIMPLE CYCLE

![Graph showing performance metrics for different simple cycles under varying temperatures.](image-url)
THERMAL REGENERATION CYCLE

HEEFF = (T1-T8)/(T5-T8)
THERMAL REGENERATION CYCLE

Thermal Regeneration VCRC Performance for a given compressor
POWER REGENERATION CYCLES

Top Power Regeneration Cycle

Bottom Power Regeneration Cycles
Condenser TQ chart

Evaporator TQ chart

Bleed Vapor Generator TQ chart

$$\text{VBGEFF} = \frac{(T_{5j} - T_{6j})}{(T_{5j} - T_{bj})}$$
SELECTION AND SIZING OF THE VPA

Compressor and Expander Processes

Compressor and Expander through Flow Section
OPTIMIZATION RESULTS

Top Power Regeneration Cycle

Bottom Power Regeneration Cycles

1B1TG R404a Tk=+40°C Tev=-40°C

1B1BG R404a Tk=40°C Tev=-40°C

2B1BG R404a Tk=40°C Tev=-40°C
Application of the 1D MLM leads to provide the profiles of compressor and expander impellers.

SELECTION AND SIZING OF THE VPA
THE VPA SET UP AND TEST BENCH

Volute, Stator Vanes and Variable Nozzle Geometry

Test Bench
POWER SAVING

\[ 2B1G \, T_k = +40 \, ^\circ C \, T_{ev} = -40 \, ^\circ C \, R404a \]
CONCLUSIONS

1. THE BOTTOM POWER REGENERATED VAPOR COMPRESSION REFRIGERATION PLANTS HAVE BEEN PROVEN TO BE THE BEST PRESENT ENERGY SAVING SOLUTIONS;

2. THE IMPLEMENTATION OF CAR ENGINE TURBOCHARGER TECHNOLOGY IS CHEAP, RELIABLE AND EFFICIENT;

3. TESTS HAVE SHOWN THAT THE BOTTOM POWER REGENERATED REFRIGERATION PLANTS EQUIPPED WITH TURBOMACHINERY BASED VAPOR PRESSURE AMPLIFIERS IS A MATURE TECHNOLOGY TO BE APPLIED;

4. IN PUBLIC ADMINISTRATION BUILDINGS, EQUIPPED WITH AIR CONDITIONING PLANTS, ABOUT 9-12% AVERAGE ENERGY SAVING IS EXPECTED.

5. IN AIR CONDITIONED BUILDINGS THAT INCLUDE COMMERCIAL & INDUSTRIAL ACTIVITIES, AN AVERAGE POWER SAVING OF ABOUT 20% CAN BE ACHIEVED.
THE END