

AMMONIA REFRIGERATION

Need of energy efficiency in cold storage

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AAR Vadodara 6th April 2023 1


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Preamble

- ▶ Any cold storage refrigeration system consumes around 80 to 90% of total energy.
- ▶ The cost of energy is increasing.
- ▶ Saving energy is increasing profit

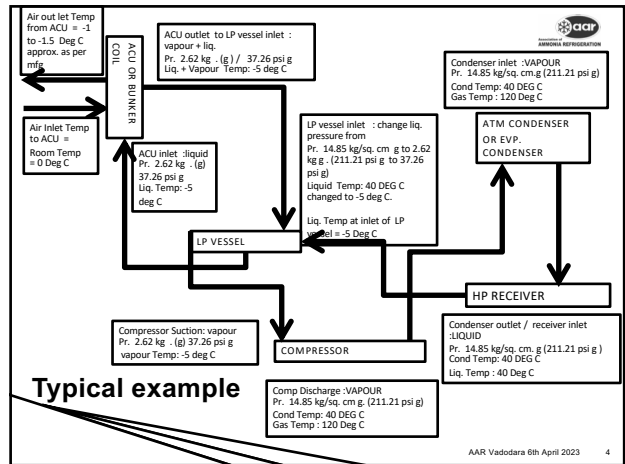
AAR Vadodara 6th April 2023 2



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Energy efficiency : When & Where ?

- ▶ New project : inbuilt design for efficiency
- ▶ Existing plant
- ▶ CAPEX / OPEX / ROI

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Energy efficiency : When & Where ?

- ▶ New project : inbuilt design for efficiency

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▶ The comparative refrigerant performance per kW of refrigerant @ -6.7/30 Deg. C EVP/Cond temp. (ASHRAE Fundamental 2013 table 8 page 29.8)

Refrigerant	Evp. Pr. MPa	Cond. Pr. MPa	Comp. Ratio	Ref. effect kJ/kg	Power consum . kW	C.O.P.
Ammonia	0.235	1.162	4.94	1103.1	0.210	4.76
R-22	0.295	1.187	4.02	162.67	0.214	4.66
R134 a	0.163	0.767	4.71	148.03	0.216	4.6
R 410 A	0.478	1.872	3.92	167.89	0.222	4.41
R 404 A	0.365	1.42	3.89	114.15	0.237	4.21
CO2	2.254	7.18	3.19	133.23	0.192	2.69

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► The comparative refrigerant performance for 100 kW capacity @ -5 Deg. C EVP temp.

Ref.	Shaft power kW@ 40 Deg C cond. (Water cooled)	Diff. in shaft power w.r.t Ammonia	extra energy bill for 15 years of plant life (RS)	Shaft power kW@ 52 Deg C cond. (Air cooled)	Diff. in shaft power w.r.t Ammonia	extra energy bill for 15 years of plant life (RS)
R-717	26.5	0		26.5*	0	
R-407c	30.92	4.42	15,91,200	43.17	16.67	60,01,200
R-404a	45	6.56	23,61,600	45.11	18.61	66,99,600

* there is going to be further savings due to cooling tower / evp cond fan over fans of air cooled cond.

Energy saving / COP example between R-22 v/s Ammonia for reciprocating compressor @ -40/40 evp. cond. temp

Item	Unit	R-22	Ammonia R-717
Capacity	kW	57.14	57.14
Shaft power	kWh	44.94	38.79
Difference in shaft power	kWh		6.15
Per day hr	hr		18
Number of days in a year	day		300
Electricity cost per unit	Rs/unit		7
Saving / year	Rs.		2,32,470
COP		1.27	1.47

Initial steps
Formulate basis of design.

S. No	Item	Unit	room
1	Room Size (Out to out)		
	L	m	
	B	m	
	H	m	
2	PUF / EPS thickness	mm	
3	Product to be cool		
4	Type of packing		
5	kg/packing	kg/packing	
6	Total product storage capacity/Daily loading	MT	
7	Ambient Temp	° C	

Understanding Energy Efficiency

- Refrigeration load requirement
- COP
- Part load and full load operating data

- Understanding Energy Efficiency
- Equipment :-
1. Compressor
 2. Condenser
 3. Evaporator
 4. Pr. Vessels
 5. Controls and automation
 6. Piping and insulation

Energy efficiency : When & Where ?

- Existing plant

Carry out detailed study of existing Plant

- Refrigeration load requirement
- Recorded data
- Electrical load
- COP : existing plant
- Part load and full load operating data

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Collect documentation

Recorded data assessment

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Effect of Suction Pressure

Item	unit	-5 Deg C evp temp.	-10 Deg C evp temp	-12 Deg C evp temp.
Evaporation temp	° C	-5	-10	-12
Suction Pressure	kg/ cm ² / PSI	2.62/ 38	1.97/ 28.95	1.73/ 25.43
Comp. capacity	TR	75.64	75.64	75.64
Shaft power	kW	69.08	80.7	85.11
Extra kW / hr if we operate at lower evp temp.	kW	----	11.62	16.03
No of hours per day operation	hr	---	18	18
No of days in year march to Nov.	days	----	270	270
Electricity cost / unit effective	Rs/ unit	----	12	12
Extra cost of electricity for 1 year	Rs	-----	6.77.678	9.34.869

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Effect of discharge pressure on energy consumption .

Item	Unit	Discharge Pressure kg/cm ² (g) @ 40 Deg C design condensing temp.		
Operating pressure	kW /PSI	12.34 / 181.4	14.92 / 217.85	16.18 / 237.85
Comp. capacity	kW	80.26	80.26	80.26
Shaft power	kW	62.0	73.29	79.2
Shaft power Diff. /hr.	kW		11.29	17.2
No of hours per day operation	hr	---	18	18
No of days in year march to Nov.	days	----	270	270
Electricity cost / unit effective	Rs / Unit	----	12	12
Extra cost of electricity for 1 year	Rs / year	-----	6.58.432	10.03.104

AAR Vadodara 6th April 2023 16

Air Vs. Power Loss

% of Air by weight	0.5	1.0	2.0	4.0
Air Pressure in PSI	1	1.6	3.2	7
Power %	0.8	1.4	2.8	6.5


for -15°C Evaporating and 38°C Condensing

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Ammonia-water Relationship Solubility Of Ammonia With Water

% Dilution	Saturated Suction Temperature at		
	-0.3 Kg/ cm ² g	0 Kg/ cm ² g	2.0 Kg/ cm ² g
0	-40.2°C	-33.3°C	-8.9°C
10	-38.6°C	-31.6°C	-7°C
20	-36.4°C	-28.9°C	-3.9°C
30	-32.2°C	-24.4°C	2.3°C

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Energy saving achieved by replacing existing single stage compressors by two stage compressor

Sr. No	Item	No of days	Unit consumes kWh	Electricity Bill (RS)
A)	kW of old compressor Previous year 2013	114	8,62,175	58,70,596
B)	kW after compressor replacement for similar month this year 2014	114	5,59,632	35,36,807
C)	Saving achieved	114	3,02,543	23,33,789

Product store in both years is : 2400 MT
Compressor running hours after re designing reduced from 24 hours to 16 hours.

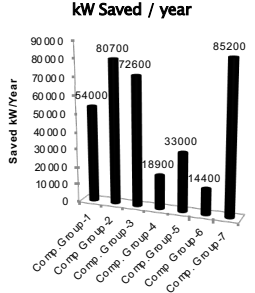
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Test case 1 : Energy conservation by Automation of compressor capacity control


- 7 groups according to application were formed and PLC based compressor controller were installed, for capacity control along with lead , lag sequencing operation.
- As shown substantial energy saving was thereby achieved.

kW Saved / year



Comp. Group	kW Saved / year
Comp. Group-1	54000
Comp. Group-2	80700
Comp. Group-3	72600
Comp. Group-4	18900
Comp. Group-5	33000
Comp. Group-6	14400
Comp. Group-7	85200

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Conclusion

- All personnel are well trained , discipline is maintained and they are well taken care off.
- Owner/Top management give topmost priority and continuously monitor safe operation of plant and allocate proper funds and resources.
- Moto should be **SAFETY FIRST**

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THANK YOU

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