The Shirpur Education Society's

R. C. Patel College of Engineering and Polytechnic, Shirpur

Department of Mechanical Engineering

NAME OF COURSE: - Power Engineering (PER)

CODE OF COURSE: - 315371

SEMESTER: - TYME-5K

SUBJECT TEACHER: - Mr. B. S. Patil

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QUESTION BANK

Chapter 5. Energy Efficiency in Air Compressor & Refrigeration and Air Conditioning

Program Name: Mechanical Engineering **Program Code:** ME5k

Name of Subject & Code : Power Engineering (315371) **Semester :** Fifth

Date -14/07/2026

Q. NO.	QUESTION	DETAIL	MAPPING
1	List any four factors affecting the performance of following systems :– i) Compressed air system ii) Refrigeration and air conditioning system.	W-25 4 M	TLO-5.1,5.2 R
2	Recommend any four energy saving opportunities for an office air conditioning system.	W-25 4 M	TLO-5.2 A
3	Explain the role of the main component in a compressed air system.	W-25 4 M	TLO- 5.1 U
4	Explain the factors affecting the efficient operations of the compressed air System.	OTHER- 4M	TLO- 5.1 U
5	Recommend any four energy saving opportunities for a compressed air system.	OTHER- 4M	TLO- 5.1 R
6	Give the checklist for energy efficiency in a compressed air system. AND Refrigeration and air conditioning system.	OTHER- 4M	TLO-5.1, 5.2 R

14/07/2025

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Chapter- 05- Energy Efficiency in Compressor, & Total Hrs = 05, Total Marks = 08. RAC.

5.1. Compressed air system components.

a. Intake air filter, b. inter stage coolers.
c. after coolers d. Air dryers.
e. moisture drain trap f. Receivers.
g. piping network h. filters.
i. Regulatorr j. lubricators.

a. Intake air filters:- Prevent entry of dust & avoids sticking to valves, scoured cylinders & Excessive wears etc.

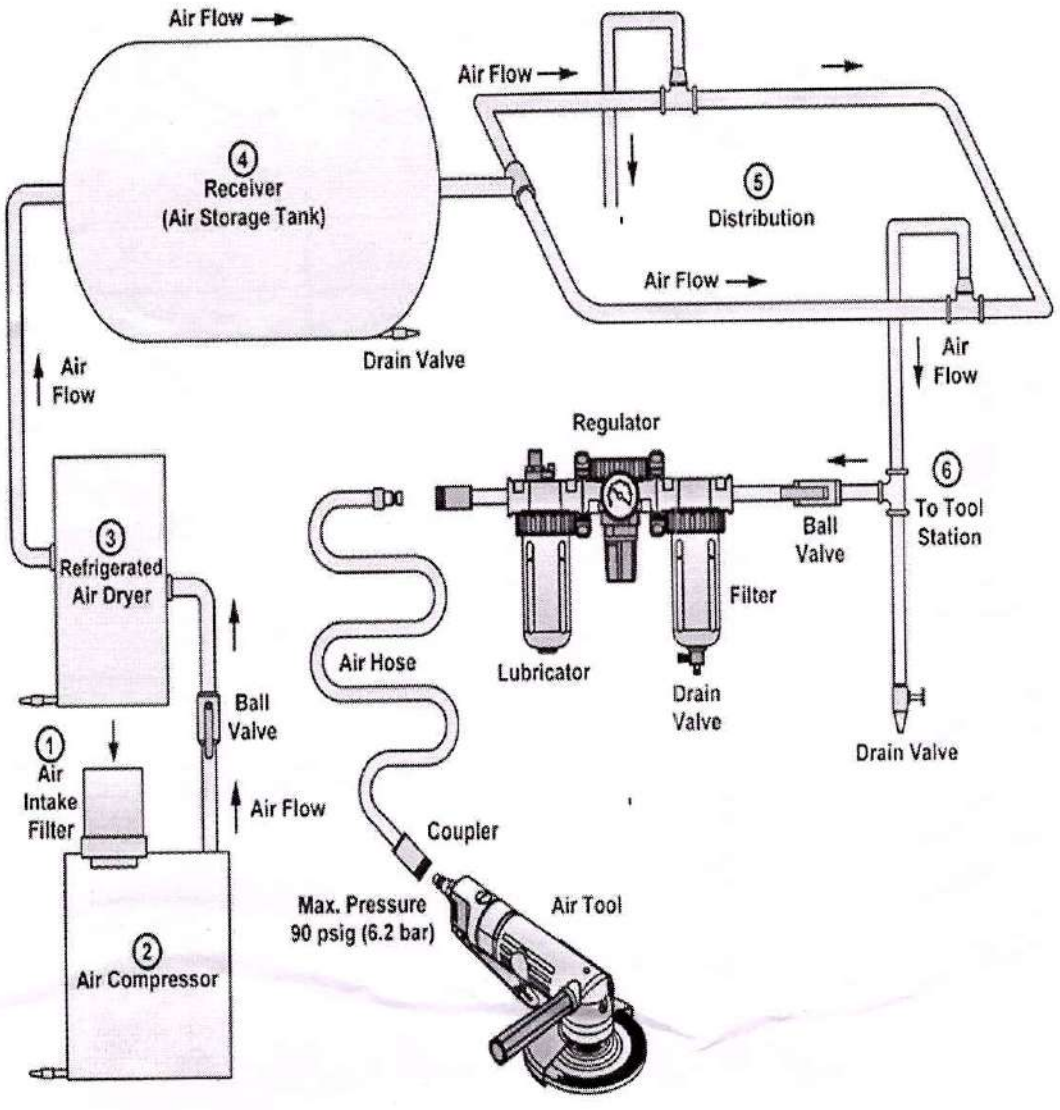
b. Inter-stage Coolers:- To reduce the temperature of air before it enters the next level stage to reduce the work of compression & increase efficiency. They are Normaly water cooled.

c. After coolers:- removes moisture in air. by Reducing temperature.

d. Air dryers:- escaped moisture after 'after cooler is removed by air dryer by using absorbents like silica gel, activated carbon, or refrigerant dryers or heat of Compressor. dryers. [

e. Moisture Drain traps:- removes moisture in compressed air. eg. manual drain cock, time based valves etc

f. Receivers:- provided as storage or smoothing pulsating air output reducing pressure variation from the compressor



* Factors affecting efficient operations of compressed air system.

1] location of compressors:-
it should be located where cool, clean, dry air will be available at intake.
1] as, "Energy 4°c rise in inlet air temperature results in a higher Energy consumption by 1%. to achieve equivalent o/p.
2] Dust free intake minimizes the pressure drop
3) Dry air intake minimizes the ~~o/p~~ power consump
4) Elevation - Compressor located at higher altitude consumes more power than those at sea level. for same output.

2] Cooling water circuit:-
Cooling water is used to cool the compressor, Compressed air system including inter-coolers after coolers, & Recirculated through compressed air system.
So cooling water must be properly treated to reduce the TDS level which causes the scale formation leading to increased pressure drop in circuit & also reduced heat transfer by insulation effect
Use of treated water or purging a portion of cooling water [Blow down] periodically can maintain TDS level within acceptable limits.
It is better to maintain pH by addition of chemicals, & avoid microbial growth by addition of fungicides & algaesides.

3] Efficacy of inter cooler & after cooler:-

"Increase of 5.5°C in the inlet air temperature to second stage results in a 2% increase in the specific Energy consumption. Use of water at lower temperature reduces sp. power consumption. How ever very low cooling water temperature could result in condensation of moisture in the air, which if not removed would lead to cylinder damage.

Similarly inadequate cooling in after-coolers [due to fouling, scaling etc] allow warm, humid air into the receiver, which causes more condensation in air receivers & distribution lines, which leads to corrossion, pressure drops & leakages in piping.

4] pressure settings:-

Compressors operates between pressure ranges called as loading (cut in) & Unloading [cut out] pressure.

eg. Compressor operating between 6-7 kg/cm^2 means that compressor unloads at 7 kg/cm^2 & loads at 6 kg/cm^2. loading & unloading is done by pressure switch.

for the same capacity, a compressors consumes more power at higher pressure.

They should not be operated above their optimum operating pressure which is waste & leads to excessive wear.

* checklist for Energy Efficiency in compressed air system.

a]. Ensure air intake to compressor is not warm & humid by locating compressors in well-ventilated area or by drawing cold air from outside.

"Energy 4°C rise in temperature of intake air will increase power consumption by 1 percent.

b] clean air-intake filter regularly. Efficiency of compressor will be reduced by 2percent for Energy 250mm WC pressure drop across the filter

c] Inspect Compressor valves once in six month

d] if demand is less than 50 percent of Compressor capacity either change over smaller compressor or reduced the speed of compressor.

e] Consider the use of regenerative air ~~dryers~~ dryers, which uses the heat of Compressed air to remove moisture.

f] Consideration should be given to two-stage or multi-stage compressor as it consumes less power for same air output

g] seperates air compressor must be used for different pressures.

* Need of Energy Management in compressed air system.

→ It is crucial due to their significant energy consumption & potential for inefficiency. By implimenting energy management practices, industries can reduces operational costs, improove system reliability & minimize their environment impact.

~~Deabringuess~~ :- Reasons :-

A) High Energy Consumption :-
Compressed air systems are energy intensive with compressors often consuming a large portion of electricity. In many cases, less than 10% of the energy input to a compressor is Converted into usuable compressed air.

B) Enviromental impact :-
Inefficient Compressed air systems lead to higher Carbon footprints due to increased energy consumption due to green house gas emissions.

C) Cost Reduction :-
Reduced energy consumption directly translates into lower electricity bills & operational costs for businesses.

d) System optimization :- it helps identify & addressed inefficiencies in Compressed air production, distribution & usage.

e) Preventive maintenance :-

e] preventive maintenance:- Energy Management helps in identifying potential issues & implimenting preventive maintenance measures, leading to increased system lifespan & reduced maintenance costs.

In general, Energy Management in compressed air systems is vital for cost savings, environmental responsibility & operational efficiency. It allows Industries to minimize their energy consumption, reduce their carbon footprint & enhance the overall performance of their compressed air system.

5.2. Refrigeration & air conditioning:-

* Factors affecting performance of energy efficiency of Refrigeration & air conditioning system.

→ 1] Design of process heat exchange:-

proper sizing of heat ~~exchanger~~ transfer areas of process heat exchangers & evaporators as well as rationlizing the temperature requirements to high possible values.

A 1°C raise in evaporator temperature can help to save upto 3% on power consumption

2] Maintenance of Heat exchangers surfaces.

effective maintenance holds the key to optimising power consumption.

3) System design features:-

* use of softened water for condensers in place of raw water.
* use of economic insulation thickness on cold lines. heat exchangers considering cost of heat gains & adopting practices like infrared thermography
* adoption of roof coatings / cooling systems, false ceilings
* Adoption of energy efficient heat recovery devices like air to air heat exchangers to pre-cool the fresh air by indirect heat exchangers.

* Energy savings opportunities:-

a) Cold insulation:-

Insulate all cold lines/vessels using economic insulation thickness to minimize heat gains; and choose appropriate insulation.

b) Building Envelope:-

optimise air conditioning volumes by measures such as use of false ceilings & segregation of critical areas for air conditioning by air curtains.

c) Building heat loads minimization:-

minimize the heat loads by measures such as roof cooling, roof paintings, efficient lighting, pre-cooling of fresh air by air-to-air HX, variable volume air system, optimal thermo-static setting of temperature of air conditioned spaces.

D) Process heat loads minimisation:-

minimize process heat loads in terms of TR capacity as well as refrigeration level. ie. temperature required, by way of.

a) flow optimization
b) Heat transfer area increased to accept higher temperature coolant.
c) avoiding wastages like heat gains.
d) frequent cleaning of all HX.