

# Reduce the Temperature of Atmospheric Air Using Openloop Cycle

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**ABSTRACT:** Air cycle refrigeration systems belong to the general gas cycle refrigeration systems, in which a gas is used as the working fluid. The gas does not undergo any phase change during the cycle; consequently, all the internal heat transfer processes are sensible heat transfer processes. The specific heat of air remains constant throughout the cycle. This cycle is considered as an open loop air cycle, which is an every time fresh atmospheric air is used in the process. Here the air conditioning system is based on Reversed Brayton cycle. The use of air as refrigerant overcomes the all environmental disadvantages of refrigerant like CFC, HCFC etc., which affects the ozone layer depletion. The temperature of an ideal gas can be reduced either by making the gas to do work in an isentropic process or by sensible heat exchange with a cooler environment.

**KEYWORDS:** no phase change, open loop cycle, working fluid is gas

## I. INTRODUCTION

At a global level releases of CFCs have serious environmental defects. Their long lifetimes in the atmosphere mean that in higher atmosphere where they can damage the ozone layer, thus reducing the protection it offers the earth from the sun's harmful UV rays. The chlorofluorocarbon is an organic compound that contains carbon, chlorine and fluorine, produced as a volatile derivative of methane and ethane. Due to concerns of global warming by using ammonia more risk and toxicity we need to concentrate and focus on natural's refrigerant. An air cycle system is operated in the only gaseous state. The air cycle is lower power consumption than gases state. Air is non-toxic, non-flammable, therefore easiest to handle. The conventional vapor compressors are based on the utilization of the latent heat of the refrigerant. In contrast, an air cycle system is operated in the only gaseous state, as natural refrigerants of these low temperature range, ethane and ammonia are also available in the dual compressor, however, and these have risk for toxicity and combustibility.

The COP of air cycle refrigeration is very low compared to vapour compression refrigeration systems.

- i. Air is cheap, safe, non-toxic and non-flammable. Leakage of air is not a problem
- ii. Cold air can directly be used for cooling thus eliminating the low temperature heat exchanger leading to lower weight
- iii. Design of the complete system is much simpler due to low pressures. Maintenance required is also less.

## II. LITERATURE REVIEW

Schutze et al. (1975),

An air conditioning system uses available compressed Air and feeds it into A cascade of two decompression compressors, a heat Exchanger and a moisture precipitator which discharges into the cabin. Air is bled off the cabin to Maintain a particular pressure, but a return flow for Air from the cabin is also maintained, such air being Cleaned and compressed, chilled and mixed with the Tapped air. The mixing stage is provided upstream of thesecond turbine but

## International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 3, March 2017

downstream of the first one. The compressed return flow air is either cooled before mixing in a separate cooling circuit, or is added to the tapped air flow upstream of the heat exchanger.

Ibaraki et al. (2005),

Investigated the most environment-friendly, easiest to use, and maintenance minimized system that has superior operating performance at  $-50^{\circ}\text{C}$  or lower. It has been attributed to three features. The First is the single shaft with an expansion turbine, compressor and a built-in motor. The Second is the oil-free turbo machine with an active magnetic bearing. The Third is inverter controlling for revolution. MHI has successfully made it possible not only to minimize power consumption but also maintenance. Besides, low pressure (maximum: 0.1 MPa) also leads to easy to use.

Yang, Liu et al. (2005),

With the improvement of standard of living, air-conditioning has widely been applied. However, health problems associated with air-conditioning systems and indoor air quality appear more frequently. In this paper, recent research is reviewed on air-conditioning systems and indoor air quality control for human health. The problems in the existing research are summarized. A further study is suggested on air-conditioning systems and indoor air quality control for healthy indoor air environment.

Hiroshi Igawa et al. (2005),

Mitsubishi Heavy Industries, Ltd. (MHI) has developed the most environment-friendly, easiest to use, and maintenance minimized system that has superior operating performance at  $-50^{\circ}$  or lower. It has been attributed to three features. The First is the single shaft with expansion turbines, compressor and a built-in motor. The Second is the oil-free turbo machine with an active magnetic bearing. The Third is inverter controlling for revolution. MHI has successfully made it possible not only to minimize power consumption but also maintenance. Besides, low pressure (maximum: 0.1 MPa) also leads to easy to use.

Stephen W.T. et al (2005)

Performance analysis of a feasible air-cycle refrigeration system for road transport. The idea of using air-cycle air conditioning for this type of application is well-founded by theory, but practical limitations in implementing the system can considerably decrease the performance of an ACM. A research group at Queen's University, Belfast, has designed and implemented a supercharger based ACM for refrigerated trailers in road transport applications

### III. WORKING PRINCIPLE

Reverse Brayton cycle is an important cycle frequently employed in air cycle refrigeration systems. This may be thought of as a modification of reversed Carnot cycle, as the two isothermal processes of Carnot cycle are replaced by two isobaric heat transfer processes. This cycle is also called as Joule or Bell-Coleman cycle. Open loop air cycle and T-s diagram as shown in the figure 1 and 2.

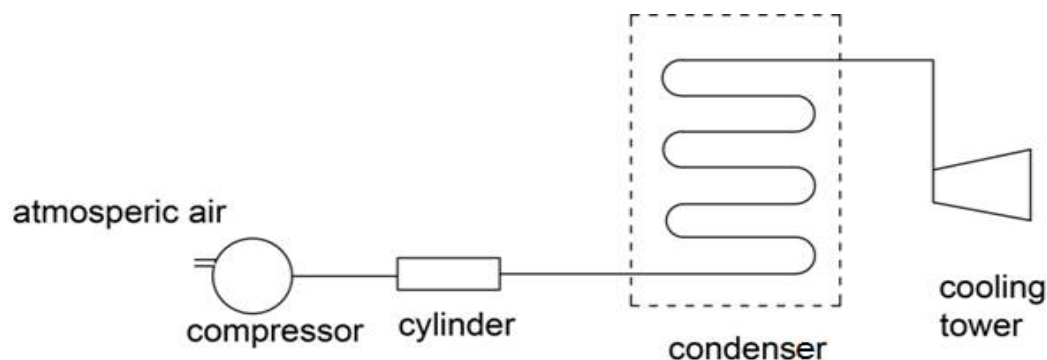


Fig 1, Open loop air cycle

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Vol. 6, Issue 3, March 2017

The air cycle consist of open compressor used to suck the atmospheric air and connected to cylinder through non return valve. These valves are used to supply gas into cylinder and it can't be return out. The pressure gauge is connected at the end of cylinder to measure the pressure inside the cylinder. The outlet valve is connected by pressure control valve to increase the pressure. The flow control valve are connected to condenser coil to reduce the pressure and then passed to the cooling tower.

In this process atmospheric air is stored in a cylinder by using a compressor. The air in the cylinder are high pressure and high temperature. The compressed air is passed through the condenser for reduce the temperature and pressure remains high, then the high pressure air is passed out through cooling tower to reduce the pressure. when pressure decreases temperature also reduces.

In this process fresh air is used from atmosphere to compression since the cycle is an open loop cycle. So the temperature of atmospheric air reduced continuously. There is no emission of chlorofluorocarbon and safe to environment. [1]

The ideal cycle consists of the following four processes. [2]

Process 1-2: Reversible, adiabatic compression in a compressor

Process 2-3: Reversible, isobaric heat rejection in a heat exchanger

Process 3-4: Reversible, adiabatic expansion in a turbine

Process 4-1: Reversible, isobaric heat absorption in a heat exchanger

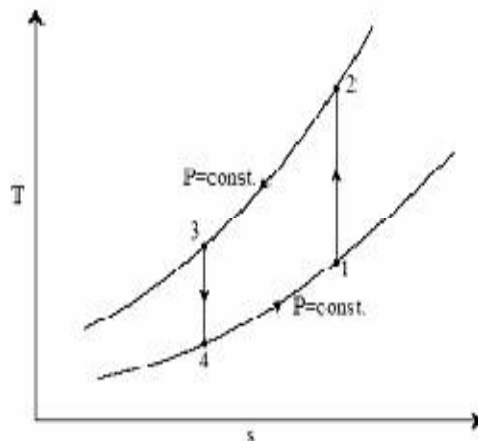


Fig2. Reverse Brayton cycle in T-s plane

Specifications of air cycle

Table 1

No	ITEM	SPECIFICATION
1	Compressor	Power - 80 w I/P - 24 v DC
2	Condenser	Dia 5 mm Length 4560 mm
3	Pressure gauge	40 bar
4	Flow control valve	0.05 – 1.0 mpa

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Vol. 6, Issue 3, March 2017

Table 2  
Comparisons with Characteristic of Handling

	AIR	AMMONIA	ETHANE
Toxicity	None	Present	None
Flammability	None	Present	Present
Corrosiveness	None	Present	None
Working pressure	Low pressure	High pressure	High pressure
Total Risk	Low	High	High

## IV. RESULT AND ANALYSIS

The reduction of temperature for various bar are follows

S.NO	PRESSURE (bar)				TEMPERATURE (°C)				ENTHALPY $m^3/kg$				EFFICIENCY ( $\eta$ )
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	h <sub>1</sub>	h <sub>2</sub>	h <sub>3</sub>	h <sub>4</sub>	
1	1.03	5.4	5.41	1.23	28.8	38.4	30.2	15.6	89.7	150.7	100.06	42.113	56.970%
2	1.3	9.2	9.24	1.2	28	42	30	10.4	89.9	184.27	100.06	29.35	66.162%

## V. CONCLUSION

The aim of this paper is to design the reduction of atmospheric air temperature by using air as a refrigerant. By working on this project, we found out that the air conditioning system based on air refrigeration cycle can be designed, assemble and feasible to run on atmospheric air. Using air as a refrigerant is safer to environment. And also reduce the maintenance cost compared to using of other refrigerant.

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