

A Review of Effective Methods and Practices to Diagnose the Vehicle AC System

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Abstract— Now a day’s mobile air-conditioning system health check at workstation / service station is done by, the feel of air flow by hands, and measures air vent temperature by thermometer. This procedure is not accurate enough to conclude whether the AC system performance is up to the mark or not. If problem persists then we instrument the vehicle with thermocouples, pressure gauges and capture the data it asks for using different equipment’s like data logger, data processor, which is time and money consuming. Hence, there is scope to improve the diagnostic method and establish standard procedure to minimize the time required for mobile AC system troubleshooting.

Major issues faced in mobile AC system are as follows-

- No refrigerant
- Insufficient refrigerant
- Excess refrigerant
- Air entered in refrigerant circuit
- Inadequate heat rejection / poor cooling.
- Blower not functioning
- AC compressor pumping failure
- Restriction in refrigerant high pressure line
- Excess opening of expansion valve
- Blockage in expansion valve

This paper documents method to diagnose mobile AC system by monitoring refrigerant circuit pressures and AC vent temperatures. Also it documents different remedies to rectify / troubleshoot the issue in minimum time.

Key words: AC System, Excess Refrigerant, Expansion Valve.

I. INTRODUCTION

Most of the passenger vehicles are fitted with the mobile AC system. The mobile AC system has main engine driven compressor, under dash AC unit with duct arrangement for calibrated air flow management, heat rejection unit (condenser) as a part of front end cooling module and dash mounted control panel.

Any maintenance of mobile AC system is difficult and time consuming because of its component mounting locations at critical places in vehicle.

In order to reduce the total time required for troubleshooting and repairs of AC system, accurate diagnosis is very much essential to avoid different trial and error methods.

This paper discusses about monitoring refrigerant pressure and AC grill temperatures to diagnose the defects in mobile AC system with the relationship of refrigerant pressures and grill temperatures enabling the layman / technician to conclude on what’s going wrong in mobile AC system.

Major 10 defects, which are faced by users in mobile AC system are studied in detail and captured in this technical paper.

II. MOBILE AC SYSTEM OPERATIONS AND ITS LIMITS-

Tests were done at different ambient conditions and operating limits are finalized for low side pressure and high side pressure. Refer fig.1 and fig.2 for operating limits at low side and high side pressures respectively

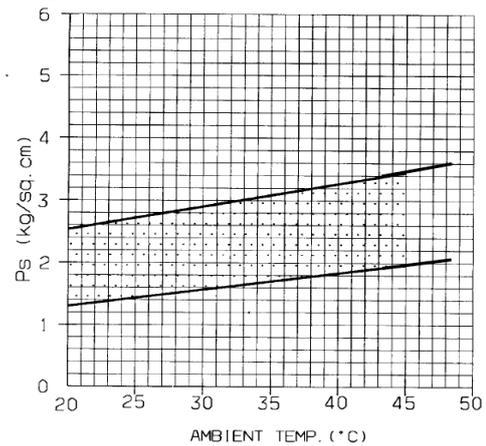


Fig. 1: Suction pressure (low side) Vs ambient temperature

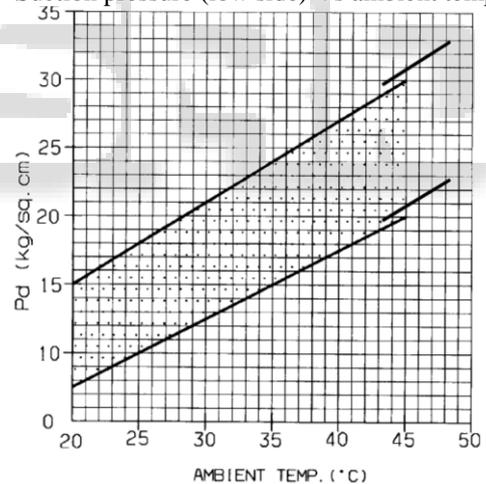


Fig. 2: Discharge pressure (high side) Vs ambient temperature.

III. TYPICAL AC SYSTEM OPERATION

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; in case of normal system operation low side pressure and high side pressure will be within the operating limit. Also the grill temperatures drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

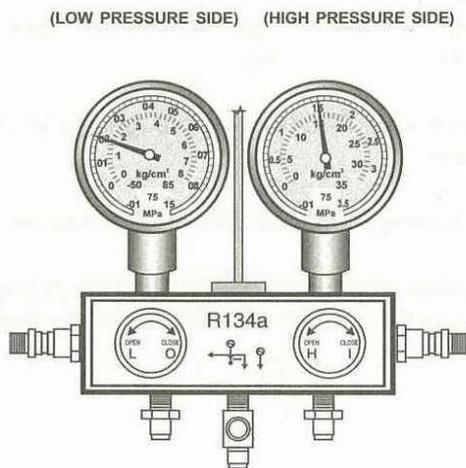


Fig. 3: Typical AC system.

Ten different defects are simulated and concluded with the refrigerant pressure and grill temperature data as follow;

A. No Refrigerant

Before starting AC system low side and high side pressure will be in equilibrium condition, if we monitor the low and high side pressures; In case of no refrigerant, low side pressure and high side pressure will be below its operating limit.

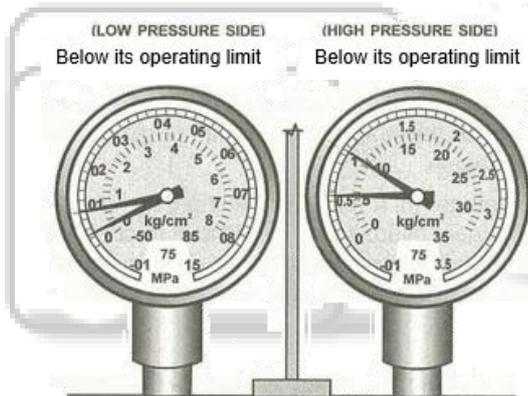


Figure 4: No refrigerant

1) Troubleshooting

In such case technician should check for any leakage through refrigerant circuit, and is advised to do vacuuming and recharge of the AC System with recommended refrigerant charge quantity.

B. Insufficient Refrigerant

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; in case of less / insufficient refrigerant, low side pressure will be above its operating limit and high side pressure will be below its operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

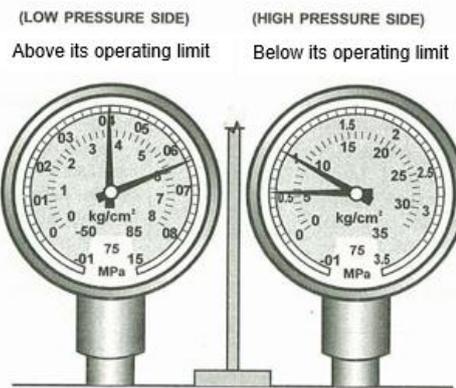


Fig. 5: Insufficient refrigerant

1) Troubleshooting

In such case technician should check for any leakage through refrigerant circuit and advised to do recover, vacuuming and recharge the AC System with recommended refrigerant charge quantity.

C. Excess Refrigerant

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; In case of excess refrigerant, low side pressure and high side pressure will be above its operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

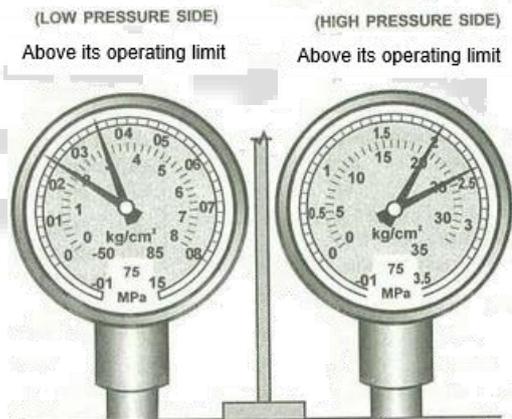


Figure 6: Excess Refrigerant

1) Troubleshooting

In such case technician advised to recover, vacuuming and recharge the AC System with recommended refrigerant charge quantity.

D. Air Entered In Refrigerant Circuit

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; in case of air entered in the refrigerant circuit, low side pressure will be within the normal operating limit and high side pressure will be above its operating limit. Also the grill temperatures was drop by 12°C than the ambient temperature, which can be measured at AC vent outlet. But for high ambient conditions there will possibility of high pressure compressor cut off and this results in poor cooling at AC vent outlet.

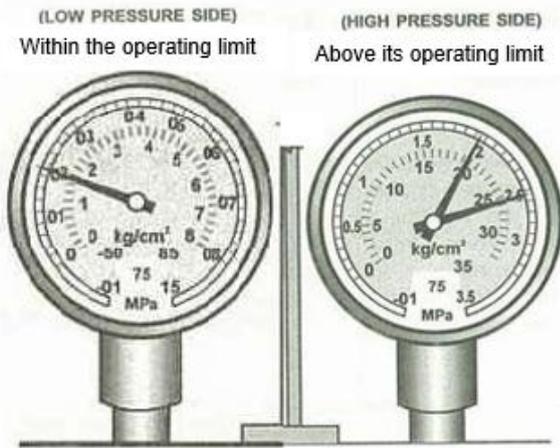


Fig. 7: Air Entered in The System.

1) Troubleshooting

In such case technician should check for any leakage through refrigerant circuit and advised to do recover, vacuuming and recharge the AC System with recommended refrigerant charge quantity.

E. Inadequate heat rejection to atmosphere

For Ambient temperature 25°C ($+ / - 2^{\circ}\text{C}$), after starting AC system, if we monitor low and high side pressure; in case of inadequate heat rejection, low side pressure and high side pressure will be above its operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

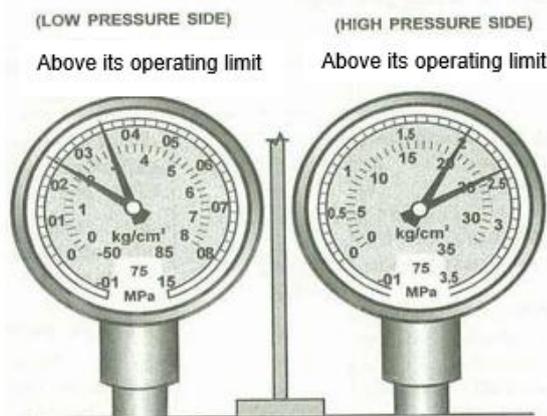


Fig 8: Inadequate Heat Rejection.

1) Troubleshooting

In such case technician should check for condenser fan electrical connection and condenser fan fuse. Also advised to remove blockages in condenser and clean the condenser coil.

F. Blower Not Functioning

For Ambient temperature 25°C ($+ / - 2^{\circ}\text{C}$), after starting AC system, if we monitor low and high side pressure; in case of blower not functioning, low side pressure will be within the normal operating limit and high side pressure will be below its operating limit. Also the grill temperatures didn't drop, which can be measured at AC vent outlet.

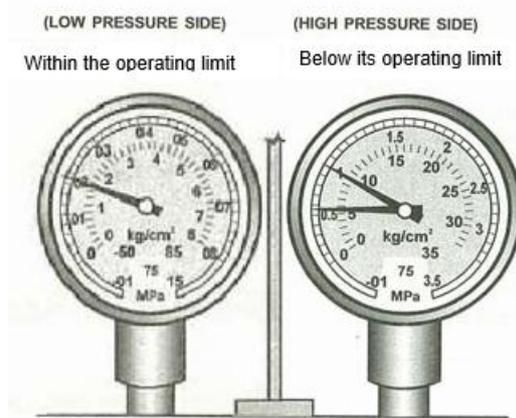


Fig. 9: Blower not working.

1) Troubleshooting

In such case technician should check the blower electrical connection and blower fuse and to clean the filters.

G. AC Compressor Pumping Failure

For Ambient temperature 25°C ($+ / - 2^{\circ}\text{C}$), after starting AC system, if we monitor low and high side pressure; in case of AC compressor pumping failure, low side pressure will be above its operating limit and high side pressure will be below its operating limit. Also the grill temperatures didn't drop, which can be measured at AC vent outlet.

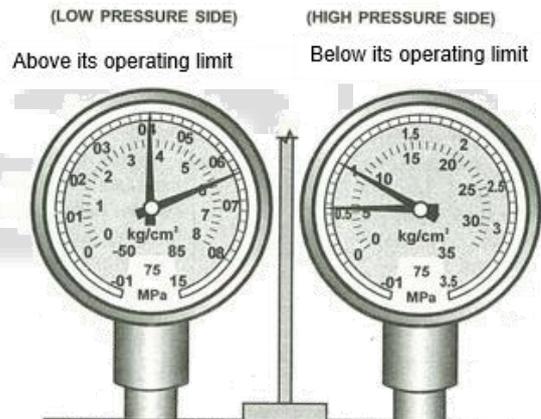


Figure 10: Pumping Failure.

1) Troubleshooting

In such case technician to check the AC compressor belt tensioning, AC fuses, compressor clutch engagement and pressure switch connection.

H. Restriction in Refrigerant High Pressure Line

For Ambient temperature 25°C ($+ / - 2^{\circ}\text{C}$), after starting AC system, if we monitor low and high side pressure; in case of restriction in discharge line, low side pressure will be within operating limit and high side pressure will be above its operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

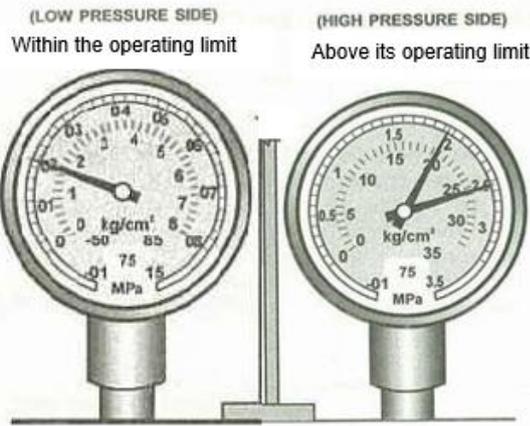


Fig. 11: Restriction in Discharge Line.

1) Troubleshooting

In such case technician to check the refrigerant circuit blockage (particularly high (discharge) pressure line). Also advised to do recover, vacuuming and recharge the AC System with recommended refrigerant charge quantity.

I. Excess Opening of Expansion Valve (TXV)

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; in case of excess TXV opening, low side pressure will be above its operating limit and high side pressure will be within the operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

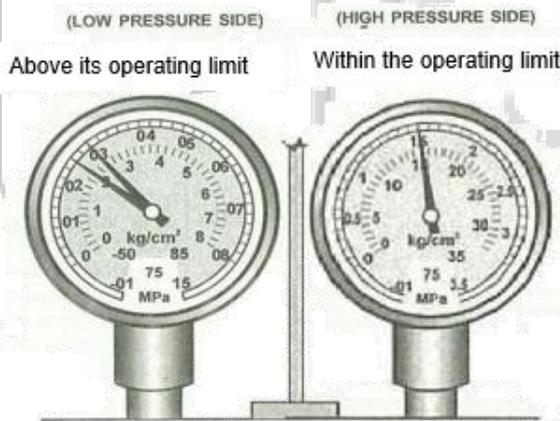


Fig. 12: Expansion Valve Stuck Open

1) Troubleshooting

In such case technician should check the TXV and is advised to replace it.

J. Blockage In The Expansion Valve

For Ambient temperature 25°C (+ / - 2°C), after starting AC system, if we monitor low and high side pressure; in case of blockage in TXV, low side pressure will be below its operating limit (vacuuming observed) and high side pressure will be above its operating limit. Also the grill temperatures didn't drop by 12°C than the ambient temperature, which can be measured at AC vent outlet.

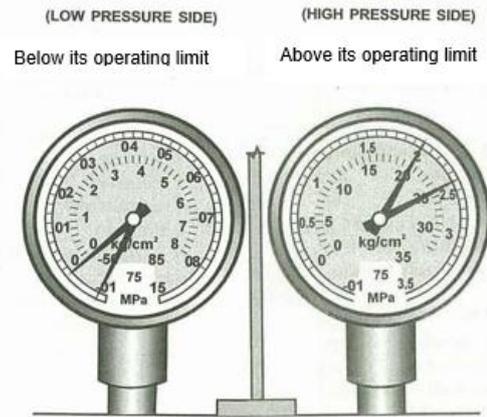


Fig. 13: Expansion Valve Stuck Closed

1) Troubleshooting

In such case technician should check the TXV and is advised to replace it.

IV. CONCLUSION

- Mobile AC repair and troubleshooting in limited time is a challenge for technician. This work helps to make it simple and easy.
- Visual checks for damage, leakage, oil stains, and noise will help to detect the defect as a problem up to a certain level. Further to it, the logic and relationship in refrigerant pressure and temperature helps to understand and conclude the faults in AC system.
- Accurate diagnosis helps to reduce the time of repair by reducing quantum of work which calls due to trial and error diagnostic methods.
- Dependability of thermal expert is reduced up to some extent.
- Troubleshooting provided with this logic, gives confidence to technician to serve customer in a better way, it can also the estimate required time and money to perform repairment and troubleshoot in advance.

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