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COLD LOAD PICK-UP FOR AIR-CONDITIONERS

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ABSTRACT

Cold load pickup (CLPU) is the well-known problem defined as excessive inrush current drawn by loads when the distribution circuits are re-energized after extended outages. During extreme weather conditions, these currents can be high enough to appear as faults or overload. This phenomenon is referred to as cold load pickup because the power supply has been unavailable for a period of time so that the load has reached a "cold" state before being re-energized. It is seen that effect of cold load pickup is more on thermostatic load (refrigerators, air-conditioners, room heaters etc).

This paper shows measurements of cold load pickup for air-conditioners. Air conditioners are working in the same way as refrigerators. Measurements have been performed on four air-conditioners at summer season. Firstly current has been measured on running condition. After that the power supply has been switched off for 1 hour. Then power supply has been switched on and current has been again measured step by step up to normal level. Cold load pickup has been measured on air-conditioners based on that reading.

I. INTRODUCTION

Cold Load Pickup is the phenomenon that takes place when a power distribution circuit is re- energized following an outage of that circuit for several minutes to several hours. When the circuit is reenergized two conditions are occurring which increases the current on that circuit above the pre-outage level. The two conditions are inrush to re-energize the loads and the pickup of more connected load due to the loss of diversity of the load. Loads that are connected at all times but are cycled on and off based on temperature or pressure reach a level of diversity once the power circuit has been energized for a period of time. Following an interruption of service to this circuit the diversity is lost and most or all of these cycling loads will be connected, drawing power for a period of time following the re-energization of the circuit. The current flow to the circuit may be significantly greater than the normal level.

II. AIR-CONDITIONERS

Fig [1] shows a simple air conditioner mechanism. Every air conditioner (also pronounced as AC, A/C or Air Cooler in certain regions of the world) has got a compressor inside it. It works to compress and pump the refrigerant gas. Compression of refrigerant produces heat. To dissipate this heat, compressed refrigerant is pumped to the condenser coils where a fan blows the heat out to outer atmosphere. During this process, refrigerant takes the liquid form.

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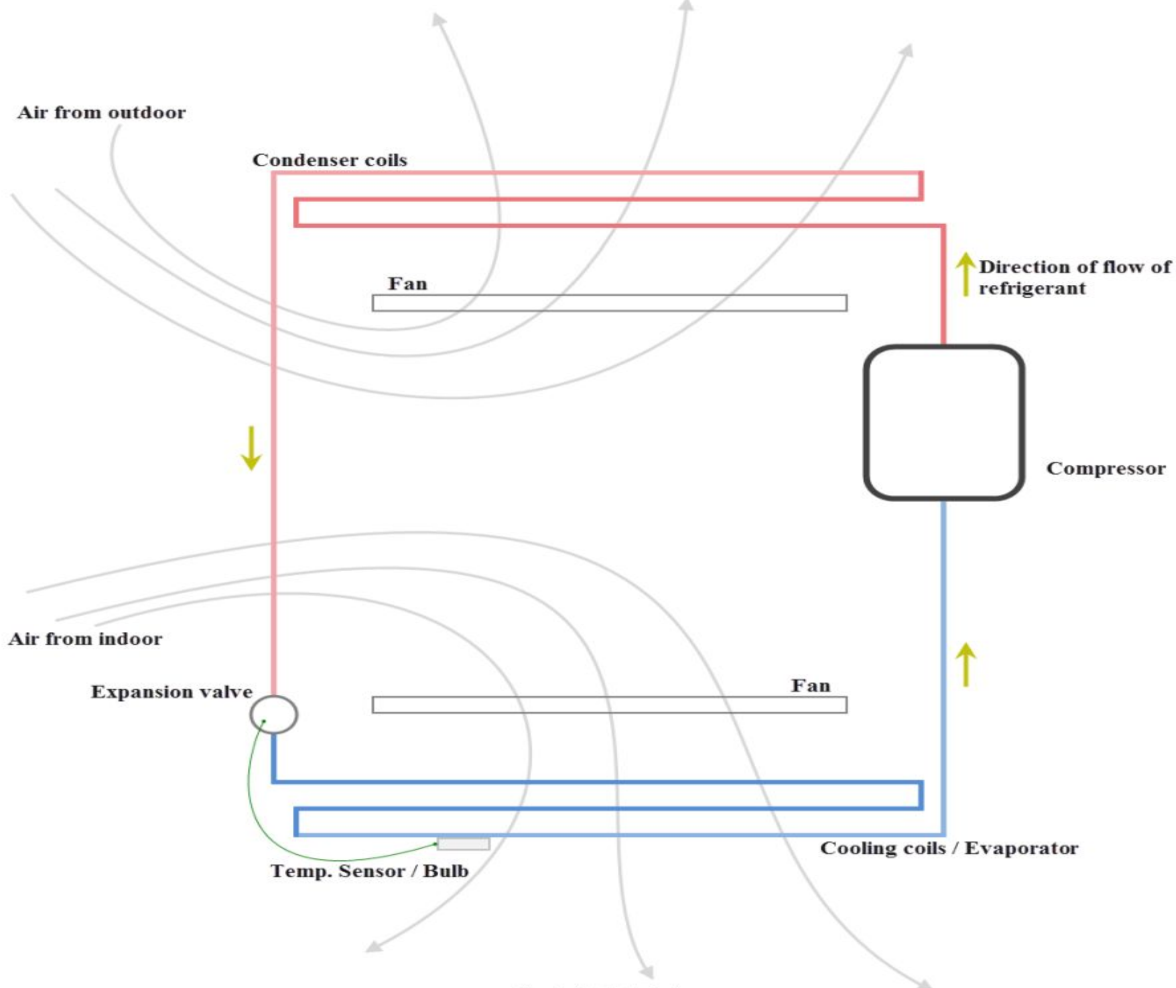

Fig [1] – Simple Air conditioner mechanism

This liquid refrigerant is pumped towards expansion valve. Expansion valve has a temperature sensor connected to it which works in correlation with thermostat settings. Expansion valve releases the appropriate amount of refrigerant to evaporator (cooling coils) where liquefied refrigerant takes gaseous form. Conversion from liquid to gaseous state due to expansion causes cooling because energy is absorbed from the surrounding. Air when passes through fins (attached to coils) gets cooled and blown to the room. The gaseous refrigerant in cooling coils then enters the compressor and gets compressed once again. The cycle continues unless the compressor is shut down.

During a disturbance in the power supply the temperature inside the cooling equipment will rise and the pressure in the condenser and evaporator will be equalized. After the initial phase when the compressor starts and the pressure in the condenser increases a quasi stationary level with a quasi constant mass flow will be achieved. The higher temperature inside the refrigerating equipment will increase the evaporator temperature which will result in a higher evaporator pressure. This gives an increased density in the evaporator and consequently also a larger mass flow through the compressor. The power consumption of the compressor will increase due to the higher mass flow. As the pressure in the evaporator and the condenser will change, also the compression ratio and thereby the volumetric efficiency will be affected. However, the condenser pressure increases more than the evaporator pressure and therefore the compression ratio will not be changed so much.

III. PROCEDURE

In order to study the behaviour after a disturbance measurements have been performed on four air-conditioners in summer season. Firstly current has been measured on normal running condition of air-conditioner. After that the power supply has been switched off for 1 hour so the air-conditioners come into cold state. Then power supply has been switched on and current has been again measured up to normal level.

Initially when the AC is switched on there is an inrush current. When this inrush current has decreased the power consumption is lower than at the end of the on period. After about 3 to 5 minutes the power consumption has increased to its peak value and a quasi stationary level is achieved. Fig 2 shows the current time graph of four air-conditioners. As shown in fig 2 the current after restoration is very high. Current comes in to normal state after several minutes. Fig 3 shows the current time graph of four air-conditioners but it's an enlarged view of this graph for a time up to 5 minutes.

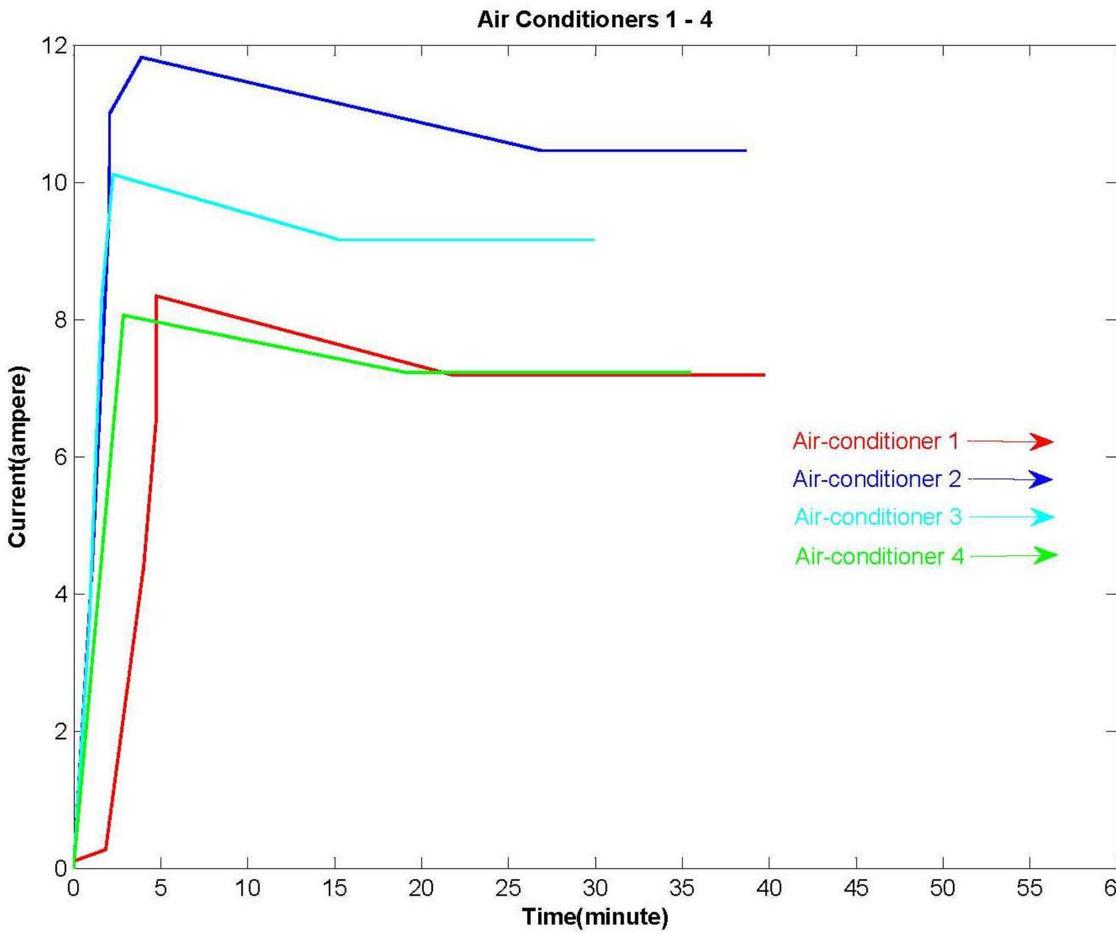

Fig [2] – Current and Time graph of air-conditioners in cold load pickup condition

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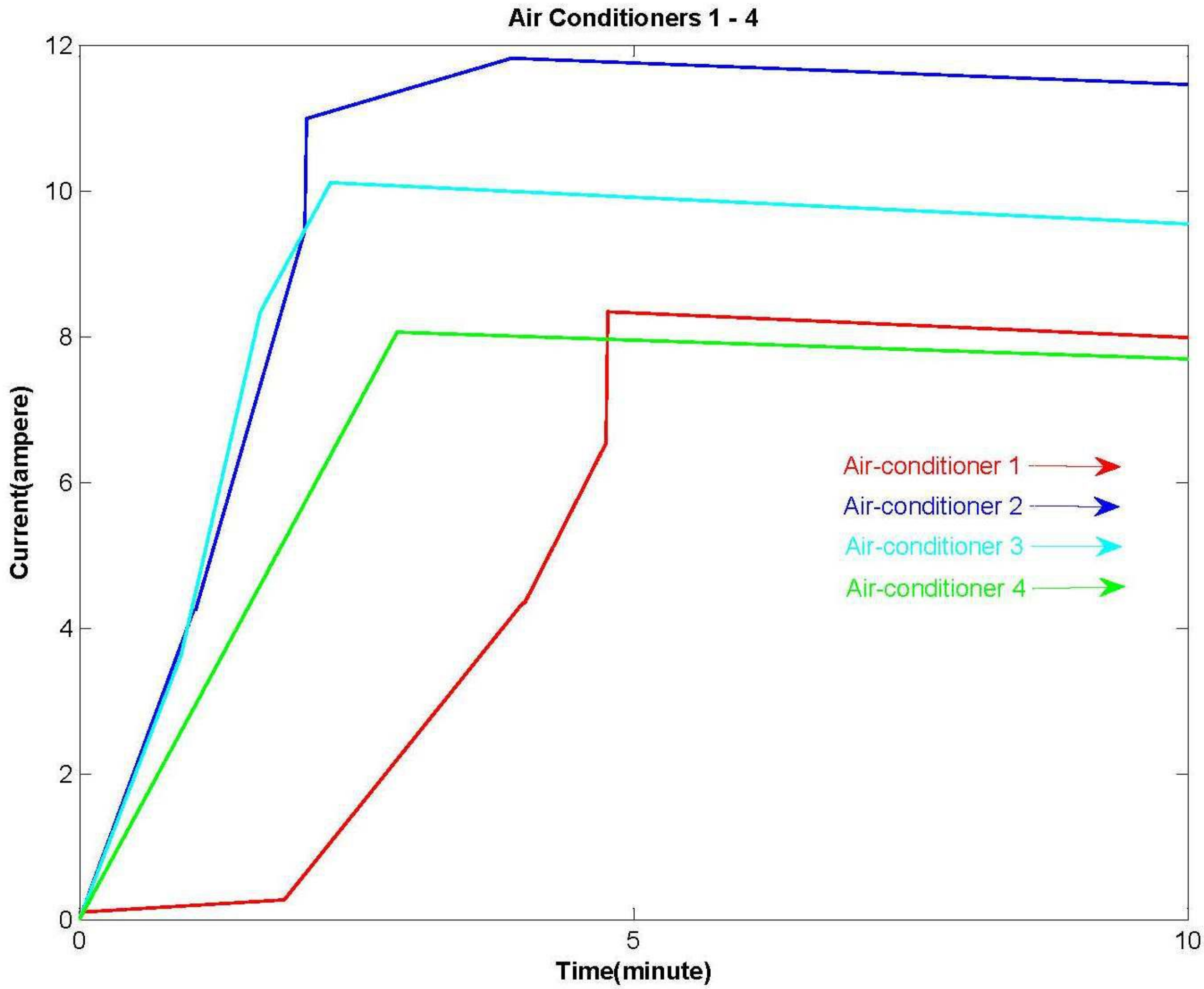

Fig [3] – Current and Time graph of air-conditioners in cold load pickup condition

Table 1 shows the current value in normal running condition and cold load pickup value. It also shows the duration and percentage of cold load pickup.

Table -1 Current measurement in air-conditioners in cold load pickup condition:

Serial no of Air-conditioners	Cold load pickup time (minute)	Peak current (ampere)	Normal current (ampere)	Percentage of cold load pickup (%)
Air-conditioners 1	17	8.34	7.19	115.9944
Air-conditioners 2	23	11.82	10.46	113.0019
Air-conditioners 3	13	10.11	9.16	110.3711
Air-conditioners 4	19	8.06	7.23	111.4799

IV. CONCLUSION

Cold load pickup takes place when a power distribution circuit is re- energized after several hours of cold state of thermostatic load. The initial current is 4 to 7 times of normal current in cold load pickup condition.

As shown in fig 2 the initial current in various air-conditioners varies from 1.10 to 1.15 times of normal current. Cold load pickup current comes into normal state after several minutes i.e. 13 minutes to 23 minutes. In this duration the overload on the distribution transformer takes place, which is one of the reasons of failure of distribution transformer

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