Abstract

The present work is concerned with the effect of using water mist technique on the air-cooled condenser performance and capacity by lowering the inlet air temperature. The effect of using extra water cooled heat exchanger as a heat sink source to increase the refrigerant sub-cooled temperature is considered also.

Four cases are introduced in the present study: a mathematical model to simulate the condenser capacity and performance, water mist technique application to the air cooled condenser, extra sub-cooled process application to the condenser refrigerant, and combination of water mist technique and extra sub-cooled process application to the test rig. Experimental investigations are introduced also to verify the reliability of the mathematical models.

The test rig used in the experimental investigation consists of A/C split unit with nominal capacity of (2 TR), extended air flow duct to simulate the summer condition, water mist system, and extra heat exchanger system. In the experimental program the ambient air temperatures are taken raises between 35˚C and 48˚C by step of 3˚C.

The present mathematical models of the condenser, the water mist technique, extra sub-cooled process, and combination of water mist technique and sub-cooled process are programmed by MATLAB. The MATLAB program input data is the measured of the thermal and fluid parameters of the air and refrigerant, and the actual shape and dimensions of the condenser. EVAP-COND software is also used to calculate the pressure drop in the two-phase flow region and the equivalent pipes length of the superheat, two-phase flow, and sub-cool regions.

Experimental investigation of thermal and fluid properties in the air and refrigerant sides of the condenser agrees well with predicted results obtained from the mathematical models. The present thermodynamic

model for the air cooled condenser is proved to be a very useful tool to analyze and estimate the condenser capacity and performance.

The air-cooled condenser capacity is enhanced with using the water mist technique and extra sub-cooled process. The results show that there is an increase of the condenser capacity by (6.499%) and (9.09%) with using water mist for ambient air temperature of 35˚C and 48 ˚C, respectively. The sub-cooled process leads to increase the condenser capacity by (3.529%) to (4.232%) for ambient air temperature of 35˚C and 48 ˚C, respectively, While the combination of the water mist system and sub-cooled process leads to increase the condenser capacity by (11.515%) and (9.959%) for ambient air temperature of 35˚C and 48 ˚C.

The coefficient of performance (C.O.P) of the A/C unit is increased by (8.42%) and (14.54%) for water mist, by (6.162%) and (7.179%) for sub-cooling process, and by (12.748%) and (20.51%) for combination of water mist system and sub-cooled process at ambient air temperature of 35˚C and 48 ˚C, respectively.

The benefits from adding water mist technique and sub-cooling process are found to be relatively high in the regions of high dry temperatures.