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Star rating and check testing of refrigerators - CPRI experiences

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With growing population, economic and industrial development, the need to examine alternative sources for generating electricity has become very important and the gap between Electrical power demand and supply in the country is increasing, so it is essential to have efforts to conserve the electricity by using energy efficient electrical products. There is always a possibility to save energy by proper usage of energy efficient components to minimize the wastage of energy in electrical appliances. The standards & labeling programme was launched for Air conditioners and Refrigerators by Bureau of Energy Efficiency (BEE) during May 2006 on voluntary basis to minimize these wastages. The manufacturers started displaying the star labels on the products from March 2007. The programme was made mandatory from January 2010. In order to verify the correctness of the star labels,BEE has introduced the check testing of the refrigerators and Air conditioners. The star rating evaluation involves the measurement of energy consumption & volume with gross & storage volume of the refrigerator along with pull down test as qualification requirement. The process of determining the energy rating consists of measuring the tested energy consumption of the refrigerator. From December 2013 to July 2014, 15 numbers of refrigerators were check tested as per BEE requirements by CPRI. The star rating of each of the models are calculated from the tests carried out at CPRI. Out of these 74% of the tested refrigerators meet the star rating claimed by the manufacturer.

Keywords: *Bureau of energy efficiency (BEE), star label, star rating, comparative energy consumption (CEC)*

1.0 INTRODUCTION

The gap between Electrical power demand and supply in the country, weather dependent hydro power stations, coal dependent thermal power stations, resistance from the public with respect to nuclear power stations, has led the power sector to look for ways and means by which electric energy is saved or conserved. 95% of the electric energy generated is being spent in the power system downstream. i.e. distribution network. Distributed network is further segmented into big industries, medium industries, small scale industries and agricultural and domestic domains. In all the above there is always a possibility to save energy by proper usage of energy efficient power system components to minimize wastage of electrical appliances like heater, luminaries, motors, washing machines, mixer, air conditioner, refrigerators etc. to name a few will conserve good amount of electrical power which is equivalent to two to three times the cost of generating the same amount of electrical energy.

In view of the above the Government of India enacted 'Energy Conservation Act 2001' and Ministry of Power has the responsibility of implementing the reforms. Under this Act 'BEE 'was formulated. And the Standards &Labeling (S&L) is one of the major thrust area identified. The S & L programme was launched during May 2006 on voluntary basis and the manufacturers started to display the labels

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on the products Refrigerator and Air conditioners from March 2007. The programme was made mandatory from January 2010.

In order to verify the correctness of the labels, BEE has introduced the check testing of the refrigerators available in the market. In the earlier days the refrigerators were picked up from the market by BEE or an authorized organization & the samples were distributed among the BEE recognized laboratories- for check testing.

2.0 ENERGY LABEL

The star rating evaluation involves the measurement of energy consumption & volume with gross & storage volume of the refrigerator along with pull down test as qualification requirement for star label. The process of determining the energy rating consists of measuring the tested energy consumption of the refrigerator as per the AS/NZS: 4474.1:2007 [1-2] and IS: 15750:2006 [3] standard i.e. Energy consumption of the refrigerator between two defrost cycles from starting of one defrost cycle to the starting of the next defrost cycle for frost free refrigerators & the energy consumption over 6 hours for the direct cool refrigerators after attaining the thermal stability. The check tests were carried out using Environmental Walk In Chamber (Figure 1) along with the temperature sensor arrangements (Figure 2).

FIG. 1 ENVIRONMENTALWALK IN TEST CHAMBER

FIG. 2 TEMPERATURE SENSOR ARRANGEMENT

The typical waveforms are shown in Figure 3 and Figure 4. The value of energy is computed for a period of 24 hours to arrive at tested energy consumption and from this annual energy consumption i.e. Projected Annual Energy Consumption (PAEC) is computed.

3.0 TOTAL ADJUSTED STORAGE VOLUME

Volume of a refrigerator / compartment is the volume enclosed within the liner. There are two types of volumes:

(a) The gross volume i.e. the measured volume enclosed within a compartment and

(b) The storage volume of a compartment is the volume of a compartment being used for food storage.

The volumes of refrigerator are measured manually using the measuring instruments like scales, depth gauge, Vernier calipers. This is achieved by dividing the Refrigerator total volume contained within the liner into convenient units of volumes of geometrical shapes which can be physically measured.

From the volumes measured the total adjusted storage volume ($V_{adj\text{-}total\text{-}dc}$) which is the rated storage volume of a compartment adjusted to

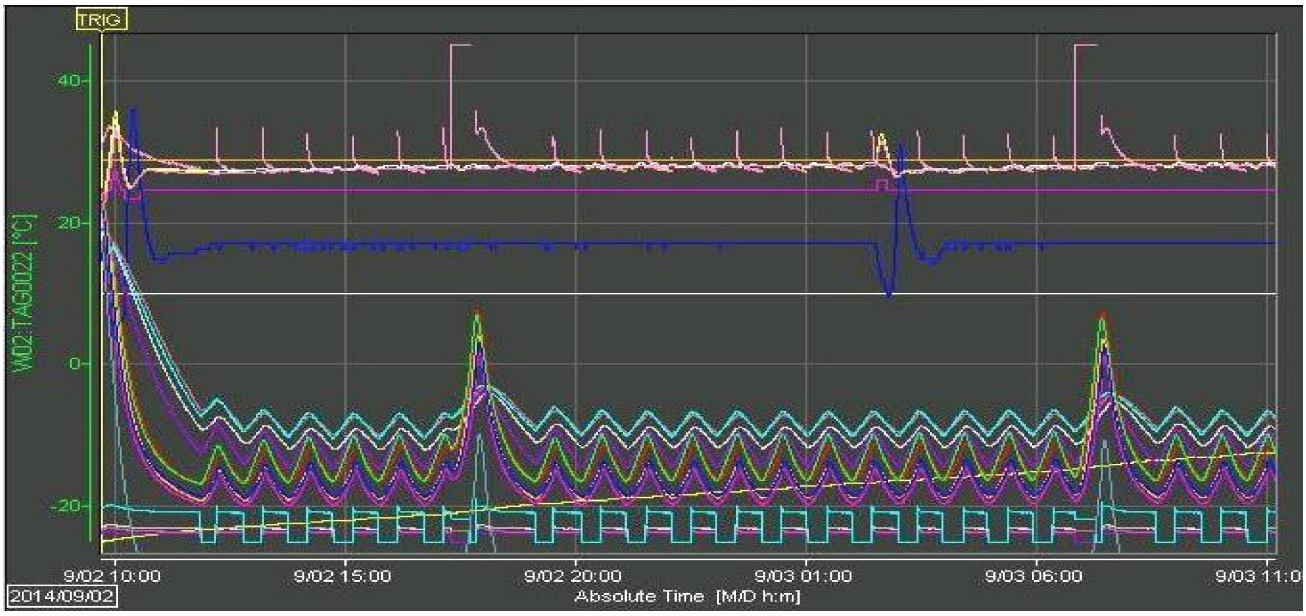

FIG. 3 GRAPH OF ENERGY CONSUMPTION TEST

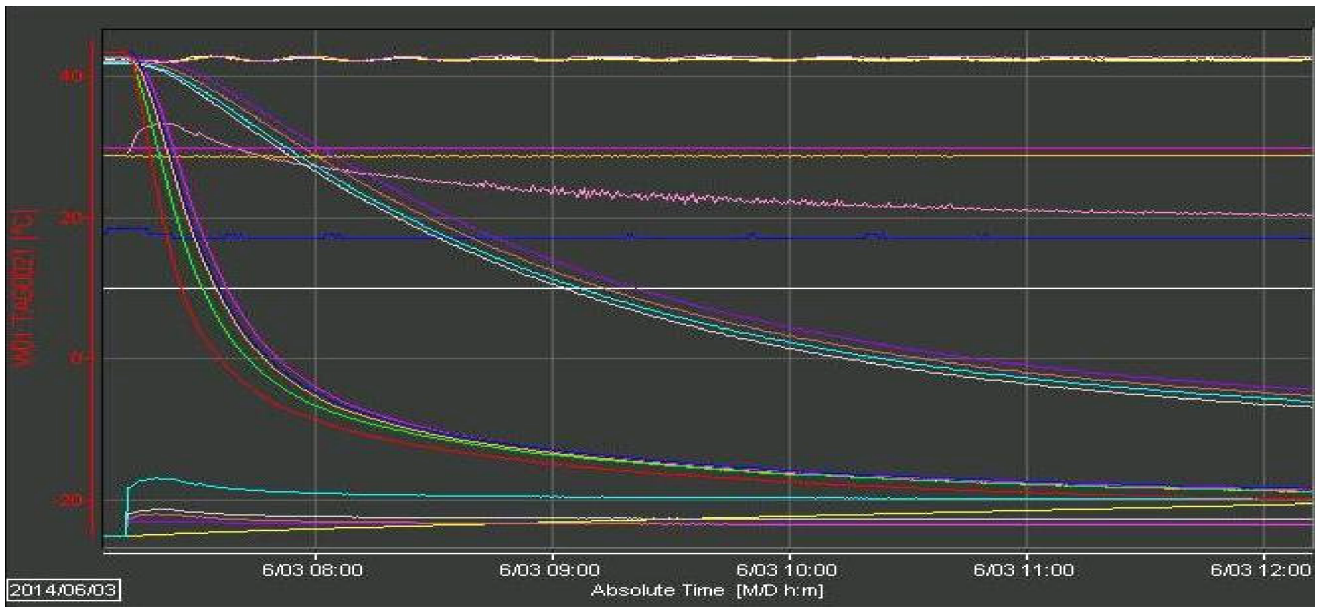

FIG. 4 GRAPH OF PULL DOWN TEST

compensate for heat loadings on spaces which are at temperature other than that of fresh food type space [4].

3.1 Total adjusted storage volume for Direct Cool Refrigerator

Adjusted Volume Factor(AVF)

$$AVF = \frac{(T_{amb(c)} - T_{FC})}{(T_{amb(c)} - T_{FFC})} \quad ....(1)$$

Where $T_{amb(c)}$ is Ambient (chamber) temperature, T_{FFC} is Fresh Food Compartment temperature and T_{FC} is Freezer Compartment temperature.

Temperature values for direct cool Refrigerators are as given in Table 1.

TABLE 1
TEMPERATURE VALUES FOR DIRECT COOL REFRIGERATOR

Sl. No.	Parameter	Temperature
1	$T_{amb(c)}$	32^0C
2	T_{FFC}	3^0C
3	T_{FC}	-6^0C

Therefore AVF = $\frac{[32-(-6)]}{[32-3]}$

= 1.31

Therefore the total adjusted volume for the direct cool refrigerator ($V_{adj\text{-}total\text{-}dc}$)

$V_{adj\text{-}total\text{-}dc} = V_{FFS} + AVF x\ V_{FS}$

$V_{adj\text{-}total\text{-}dc} = V_{FFS} + 1.31x\ V_{FS}$ ....(2)

Where V_{FFS} is Fresh Food storage volume in liters, V_{FS} is Freezer storage volume in liters.

3.2 Total adjusted storage volume for Frost Free Refrigerator

To calculate the adjusted volume factor for the frost free refrigerator consider the temperature values as given in Table 2.

TABLE 2

TEMPERATURE VALUES FOR FROST FREE REFRIGERATOR

Sl. No.	Parameter	Temperature
1	$T_{amb(c)}$	32° C
2	T_{FFC}	3° C
3	T_{FC}	-15° C

Substituting Table 2 values in equation 1 we get the adjusted volume factor for frost free refrigerator.

AVF= $\frac{[32-(-15)]}{[32-3]}$

=1.62

Therefore the total adjusted volume for the Frost free refrigerator ($V_{adj\text{-}total\text{-}nf}$)

$V_{adj\text{-}total\text{-}nf} = V_{FFS} + AVF x\ V_{FS}$

$V_{adj\text{-}total\text{-}nf} = V_{FFS} + 1.62x\ V_{FS}$ ....(3)

Where V_{FFS} is Fresh Food storage volume in liters, V_{FS} is Freezer storage volume in liters.

4.0 STAR RATING

Star Rating for refrigerator [4] can be calculated by

$(SRB)nf = K_{nf} * V_{adj\text{-}total\text{-}nf} + C_{nf}$ ....(4)

Where, K_{nf} = Constant multiplier (kWh/liter/year)

C_{nf} = Constant fixed allowance (kWh/year)

These values can be made available from the BEE schedule and the values depend on the year of manufacture and the star rating band.

By substituting the values of K_{nf}, C_{nf} & V_{adj} in the formula (4) a look up table can be generated as given below and in which the last but one column gives the kwh/year for that star rating i.e. Star Rating Band (SRB)nf. (The Table 3 is only indicative, the values of K_{nf}, C_{nf} depends on the type of refrigerator and the year of manufacture)

TABLE 3

STAR RATING BAND FOR FROST FREE REFRIGERATOR

SRB	K_{nf}	C_{nf}	(SRB)nf kWh/Year
1	0.6973	607	772
2	0.5578	486	618
3	0.4463	389	495
4	0.3570	311	396
5	0.2856	249	317

The measured value of PAEC is now compared with the last but one column of the above Table 3. The PAEC is less than the kWh/year of single star and greater than the kWh/year value of double star in the above Table 3, then the star rating of the refrigerator is single star. If the value is greater than the kWh/year of three stars and less than that of double star then the rating is double star likewise the PAEC can be compared with the other values and the actual star ratings can be obtained. For example as indicated in the Table 3 if the PAEC lies between 389 kWh/year and 495 kWh/year the star rating is 3.

In addition to the above star rating is acceptable provided that PAEC ≤ 1.1 times CEC (Comparative Energy Consumption) (which is available on the refrigerator) and Rated volume ≤ 1.03 times measured volume ≤ 5 + measured volume.

5.0 CHECK TESTING AT CPRI

From January 2009 to April 2009, 17 numbers of refrigerators were check tested as per BEE requirements of which seven were direct cool type and ten were frost-free type and from December 2013 to July 2014, 15 numbers of frost free refrigerators were check tested as per BEE requirements.

The star rating of each of the models are calculated from the tests carried out at CPRI. In some of the cases the energy consumption could not be calculated as the required target temperature could not be achieved.

The 17 numbers of refrigerators from 07 manufacturers were tested from January 2009 to April 2009 and found only 05 refrigerators complying with star label and 15 numbers of refrigerators from 06 branded manufactures were tested from December 2013 to July 2014 and found 11 refrigerators were complying with the star label. Out of the remaining 04 non complied refrigerators, energy consumption could not be obtained for 03 refrigerators as the target temperature could not be achieved and one refrigerator was failed in the pull down test.

This indicates 30% of the tested refrigerators in the year 2009 and 74% of the tested refrigerators in the year 2013-14 meeting the star rating claimed by the manufacture and there is an improvement from 2009 to 2013-2014 batches.

6.0 CONCLUSIONS

BEE has taken up this excellent activity in improving the quality of the product sold in the market and thereby saving energy and helping the consumer by way of providing the quality appliances, reduction in electricity bills and helps the nation in saving the energy. The requirement for the star rating will be still more stringent for the equipment manufactured between 2013 and 2014.

The refrigerator testing laboratory of the institute is NABL accredited and has adequate facility to carry out the star label check testing required by BEE. CPRI can test 4 refrigerators at a time and complete the test in 3-4 weeks' time.

In view of the star rating becoming more stringent manufacture can utilize the CPRI facility to cross check the rating before submitting to BEE.

REFERENCES

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[2] AS/NZS: 4474.1 : 2007 standard for performance of household electrical appliances – Refrigerating appliances"http://shop.standards.co.nz/catalog/4474.1%3A2007(AS%7CNZS)view"

[3] IS 15750:2006 Household frost-free refrigerating appliances - Refrigerators cooled by internal forced air circulation - Characteristics and test methods "http://www.standardsbis.in/Gemini/home/Home.action" enter standard name IS 15750

[4] Schedule-1 for frost free (no frost) refrigerator,"http://www.beeindia.in/http://220.156.189.29/Content/Files/Schedule1_FFR.pdf," Revision No. 3, Revision date: 01.01.2014.