Distributed in Israel by C.I.TECH

חישוב יעילות אנרגטית למערכת צ'ילרים

SPLV (System Part Load Value)

כנס מהנדסי מיזוג אוויר, תל אביב, 2018

Carrier Israel Technologies - יהונתן אפרתי

28 מאי 2018

תקציר

- דירוגים אנרגטיים מקובלים ליעילות בתפוקות חלקיות של צ'ילר בודד (IPLV, ESEER)
- דירוג אנרגטי למערכת מיזוג אוויר (SPLV)
- יישום דירוג אנרגטי למערכות מיזוג אוויר

Full load & Part load standard efficiency values

- Full load efficiency value (E.E.R / C.O.P) has two components:
  100% load and design conditions.
- Part load efficiency value (IPLV / ESEER) is a weighted average of four specific operating points.

AHRI standard 550/590 IPLV (ESEER)		
% Load	Weight	Condition
100%	1% (3%)	44 F / 85 F (7C / 30C)
75%	42% (33%)	44 F / 75 F (7C / 26C)
50%	45% (41%)	44 F / 65 F (7C / 22C)
25%	12% (23%)	44 F / 65 F (7C / 18C)

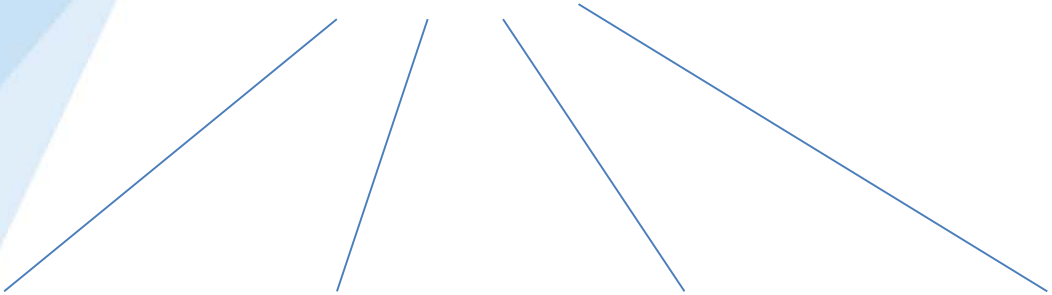
AHRI 550/590 section D2 states:

"The equation (IPLV) was derived to provide a representation of the average part load efficiency for a **single chiller only**…"

C.I.TECH

Carrier
United Technologies

SPLV



System Part Load Value

<u>system based metrics:</u>

- ✓Actual local weather
- ✓Load profile
- ✓Operating hours
- ✓Pump, Tower energy
- ✓Chiller staging

C.I.TECH

Carrier

United Technologies

Weather

- IPLV & ESEER formulas assumes weather data for an average U.S.A or European city.
- Cold climates: Part load operation & chillers shut down.
- hot climates: Loaded year around & high condenser water temp (>65°F)

	100%	75%	50%	25%
IPLV	**35°C (1%)**	**27°C (42%)**	**19°C (45%)**	**13°C (12%)**
ESEER	**35°C (3%)**	**30°C (33%)**	**25°C (41%)**	**20°C (23%)**

Month	1	2	3	4	5	6	7	8	9	10	11	12
Temp °C	17.8	18.1	20.1	24.5	27.0	29.2	30.8	31.2	30.4	28.3	24.1	19.7

C.I.TECH

Carrier
United Technologies

Performance of a Typical Building System, Weather is the Only Factor Changed in Each City

	Competitor A (R123 Centrifugal)			Competitor B (R134a Centrifugal)			SPLV Variation Between Chillers
	Chiller Full Load kW/ton	Chiller NPLV	SPLV	Chiller Full Load kW/ton	Chiller NPLV	SPLV	
BOSTON	0.597	0.506	0.505	0.597	0.534	0.483	-4.55%
CHICAGO	0.597	0.506	0.508	0.597	0.534	0.492	-3.25%
SAN FANCISCO	0.597	0.506	0.494	0.597	0.534	0.445	-11.01%
SEATTLE	0.597	0.506	0.497	0.597	0.534	0.449	-10.69%
TUCSON	0.597	0.506	0.494	0.597	0.534	0.467	-5.78%
Minimum			0.494			0.445	
Maximum			0.526			0.529	
SPLV Variation Between Sites			6.48%			18.88%	

C.I.TECH

Carrier
United Technologies

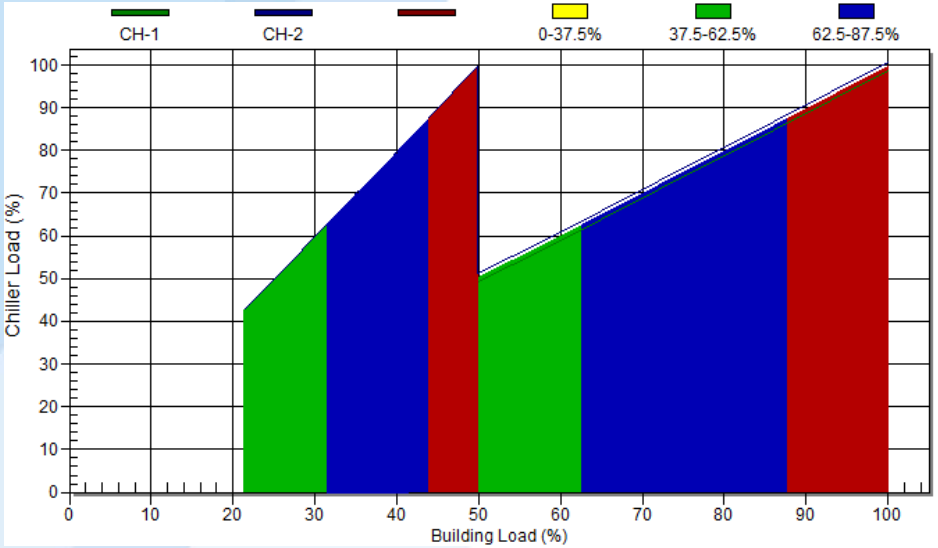
Operating hours & Load profile

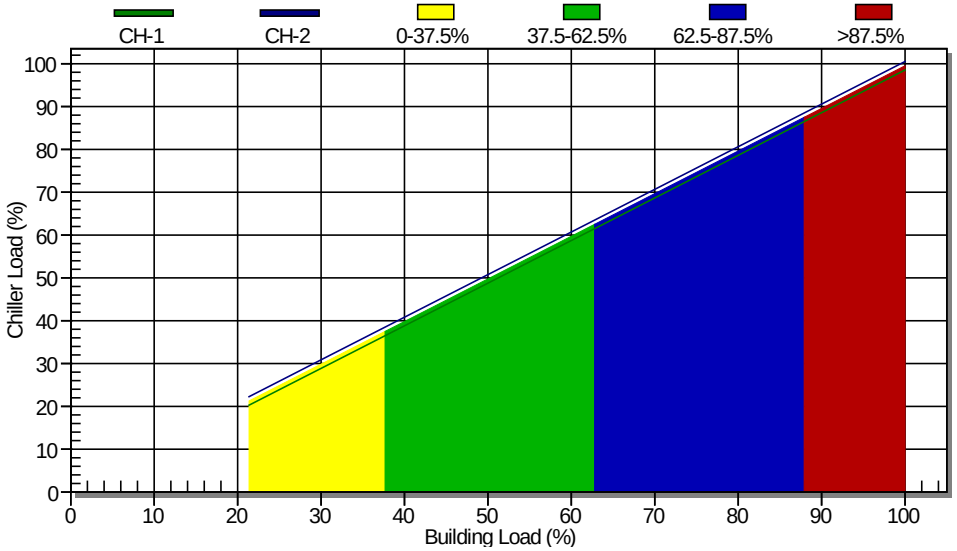
- Office: 5 days per week, open 7:00, close 18:00
- Retail: 7 days per week, open 9:00, close 22:00
- Hospital: 7 days per week, 24-hour operation
- Process: 7 days per week, 24-hour operation (constant load).

Chiller staging

Sequenced VS Equal unloading

- 2000 TR chiller plant
- 2 Centrifugal chillers constant speed





SPLV (kW/kW)

6.73 > 6.58

C.I.TECH

Carrier
United Technologies

Method comparison

	IPLV/ESEER	SPLV
Chillers quantity	1	≥ 1
Temperatures	Standard	Actual
Part load value weights	Standard	Actual
Equipment efficiency	Chillers	Chilled water System
Chiller staging	-----	Staging
Auxiliary equipment efficiency calculation	-----	Including

Application example

	System
Plant capacity	2000 TR
Operating hours	24/7
Chillers type	Constant Speed Centrifugal
Chillers quantity	2
Weather	Tel Aviv
Chilled water configuration	Primary/secondary Variable speed secondary
Condenser water configuration	Constant flow
Chiller staging	Sequenced
Cooling tower	Shared cooling tower
Tower control	Fan cycling

C.I.TECH

Carrier
United Technologies

Application example

Efficiencies	System A [kW/kW]	System B [kW/kW]
Chiller full load efficiency	6.25	6.15
Chiller part load efficiency (IPLV)	7.1	7.09
System part load efficiency – SPLV (chillers only)	6.91	6.78
System part load efficiency – SPLV (system)	3.66	3.65

C.I.TECH

Carrier
United Technologies

שאלות?

C.I.TECH

Carrier

United Technologies

Distributed in Israel by C.I.TECH

תודה על ההקשבה

יהונתן אפראימוב - yehonatani@citech.co.il