



5mm Copper tube – Usage in T3 Condition
By Harshal Upadhyay,
Head – Consumer Engineering and Factory Operations
Harshal@zamilac.com



Zamil Air Conditioners is part of Zamil Industrial.
 Zamil Industrial has 4 verticals
 Air conditioners, Steel, Insulation and Power & Telecom Solutions

Company Facts

- ❑ Zamil Industrial currently employs more than 15,000 people in 55 countries
- ❑ The company derives about 25% of its revenues from outside Saudi Arabia
- ❑ Sells products to over 90 countries

2017		
Turnover	US\$ 1.17 billion	SAR 4.4 billion
Gross Profits	US\$ 236.7 million	SAR 887.6 million
Net Profit	US\$ 28 million	SAR 105 million
Shareholders' Equity	US\$ 0.5 billion	SAR 1.87 billion
Current Paid Up Capital	SAR 160 million	SAR 600 million

- Zamil Air Conditioners is one of the largest manufacturer and market leader in Saudi Arabia for commercial, industrial and residential air conditioning products with a manufacturing capacity of 1Mn+ airconditioners.
- **Zamil product range covers the complete range of air conditioners from Windows to Screw Chillers (Capacity : 1tr – 580 Tr) & Centrifugal chiller up to 5000 Tr**
- We offer complete range of building automation controls, security, fire safety and corrosion resistance coating systems.
- **Zamil Projects** undertakes HVAC and electromechanical projects
- Joint ventures and associations with leading global players like GE, Mitsubishi etc
- Ikhtebar –an independent laboratory accredited by SASO was designed, commissioned and calibrated by Intertek, USA



Climate condition in Saudi Arabia

					10 year (SI)			
			Zone	Elevation	DB 1%	DB max	CDD18.3	CDD10
	Latitude	Longitude		m	C	C		
AL-AHSA	25.30N	49.48E	1	178	46	49.8	3573	6389
AL-MADINAH	24.55N	39.70E	1	636	44.2	47.7	3757	6715
DHAHRAN	26.27N	50.17E	1	17	44	49.3	3398	6258
GIZAN	16.88N	42.58E	1	7	37.9	42.3	4409	7451
MAKKAH	21.43N	39.77E	1	240	44.1	49.2	4758	7800
RIYADH OBS. (O.A.P.)	24.70N	46.73E	1	620	43.9	47.2	3342	6107



Data from SEEC Presentation

- Even Higher temperatures in remote areas
- Seaside areas have high temperature along with High humidity
- Sand storms
- Corrosive atmosphere in areas Petrochemical industries



Zamil's Design philosophy for T3 Climate condition

Condition	Indoor temperature DBT / WBT (deg C)	Outdoor temperature DBT / WBT (deg C)
T1	27 / 19	35 / 24
T3	29 / 19	46 / 24
SASO Max	32 / 23	52 / 31

- Reliability Test : Any Major design change is subjected to a reliability test of 200 days at 60 Deg C
- Field trial for new technologies
- Burst pressure :
compliance as per UL 484 / UL 1995



Why we explored & invested in 5mm?

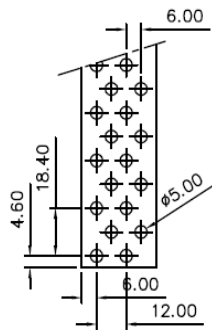
- In early 2014, there were fillers that R22 may be banned in KSA. R410a with higher operating pressure required a Copper tube with higher burst pressure (Burst pressure requirement for Cu Tube for T3 was 2700 psi+)
- Air conditioners cost were under pressure and market was not very receptive to Microchannel Heat exchangers
- Saudi had already upgraded the MEPS twice.
 - With Window AC chassis limitation, achieving higher level of T3 performance with same coil size was becoming a challenge.
 - With Higher MEPS in splits, the unit size and weight were an area of concern.

Why we explored & invested in 5mm?

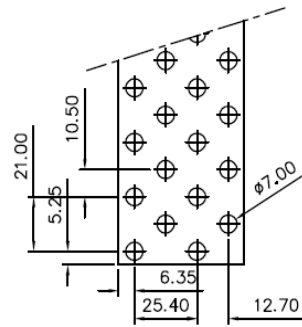
- Cost advantage : Copper
 - Cu Weight reduction : upto 25 % for equivalent performance
 - Gm / meter :
 - 5 mm : BWT : 0.22 mm, 34 g/M, BP : 2900 psig
 - 7mm : BWT : 0.25 mm, 52.5 g/M, BP : 2500 psig
 - 5/16" : BWT : 0.27mm, 68 g/M, BP : 2200 psig
 - Actual Cost reduction is lesser due to high fabrication cost of 5mm.

Why we explored & invested in 5mm?

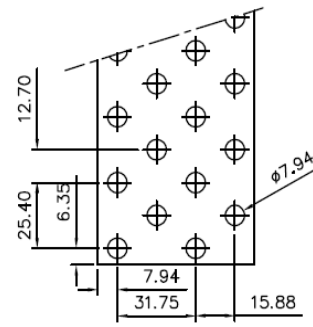
- Cost & Design Advantage : Aluminium
 - Fin pitch can be reduced to increase the primary surface area
 - Eg. Pitch of 3/8" & 5/16" tube is 25.4mm and 7mm is 21mm. 5mm can be 18.4 mm and even lower. Hence, no. of tubes per coil can be increased



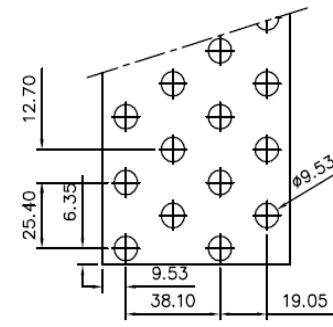
5mm. FIN



7mm. FIN



5/16" FIN



3/8" FIN

- Window AC : Small improvement in airflow due to reduced tube dia and fin width

Why we explored & invested in 5mm?

- Cost advantage
 - Aluminium weight reduction if one reduces the fin width
 - Refrigerant quantity reduction : 20 – 30 % per unit
 - Reduced refrigerant quantity gives advantage while using Flammable refrigerants where there are quantity constraints.
 - Weight reduction : Outdoor unit weight reduction by 2-3 Kg.
 - Discharge pressure at T3 and SASO Max reduces by 3 to 5%
 - To comply to UL 484 & UL 1995, Burst pressure requirement for Window AC with R410a refrigerant goes above 2500 psig. 5mm is the only cost effective option

Why we explored & invested in 5mm?

- Productivity improvement :

Fin Press output gets increased

Fin Width for AL and MHG coils

30.625"	777.875 MM
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Machine capacity 60 Tons

Fin Length = 404.80 mm & speed 220 SPM

	5/16" (7.938 mm)	7MM	5MM
Hole Dia	5/16" (7.938 mm)	7MM	5MM
# of holes in Fin length	16	19	22
Fin width	15.875	12.7	12
Pitch	1" x 5/8'	21 x 12.7 mm.	18.4 x 12.0 mm.
Actual # of rows	48	60	66
Increase in capacity WRT 5/16" by # of rows		25%	38%
Drop in Capacity WRT 5/16" by increase in holes		19%	38%

Zamil : Our journey so far...

- Design validation :
 - System balancing
 - 200 days Reliability & Field trial
- Production :
- 2016 – 2018 : 350K+ Window Acs manufactured
- 2017-18 : 20K+ Splits manufactured

Usage across

- All compressor type : Reciprocating , Rotary and Scroll
- Refrigerant type : R22 and R410a
- Markets : Saudi Arabia, UAE, Oman, Qatar and Bahrain

Note : In 2016, we also ordered one more fin press and fin die

1. Fin Press*
2. Fin Die *
3. Expander
4. Hair Pin Bender
5. Return Bender
6. Ring Loading machine



6 months later, we purchased one more Fin press and Fin die

Challenges

- Copper tube :
 - Supply Chain : Limited suppliers with limited capacity available.
 - Fabrication cost of 5mm is much higher than 7mm. Due to productivity issues, suppliers prefer to produce more of non-5mm copper tubes. (More Kg output/hr for higher dia tubes)
- Design
 - Pressure drop of 5mm is higher hence need to redesign the condenser circuit
- Production :
 - Handling of tubes is critical
 - Lacing of coils is a bit slower. Due to the smaller dia of tube, it tends to warp while pushing into the fins.

A landscape featuring a vibrant green hill in the foreground, a single, full-canopied tree standing on the crest of the hill, and a bright blue sky filled with soft, white clouds. The overall scene is peaceful and natural.

Thank You

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