Optimum Fin Pitch vs. Extrusion Length – a Theoretical Study

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Very often, there is a misconception that the larger the heat sink dissipation area, the better. Which is why one sometimes sees people using extrusions of say a cross section of 100x40mm with a length of e.g. 400mm, having a fin pitch of e.g. 10mm and the fins lying horizontally.

This is probably the most inefficient way of using finned heat sinks in natural convection (i.e. no forced cooling). As the design guide for most heat sink manufacturers would tell you, the most efficient way to use a heat sink extrusion is a wide heat sink, with short vertical fins, and black anodised.

But how about those tower type housings? Wouldn't they work at all ?

To answer this in a scientific manner, I first calculated the thermal resistance of a series of heat sink geometries with the same cross section and extrusion length, but with variable fin pitch dimensions. These calculations were done using Dr. Åke Mälhammar's excellent Nat-Sink software, with which I have good experience.

The results are listed as follows. As one can see, having a large number of fins close to each other is totally counterproductive, even though the total area and also the volume of aluminium both increase. On the contrary, the thermal resistance of a heat sink only increases marginally at fin pitches larger than the optimal (minimal) pitch. Thus, <u>it is always advisable to go for a larger pitch than one that is too small.</u>

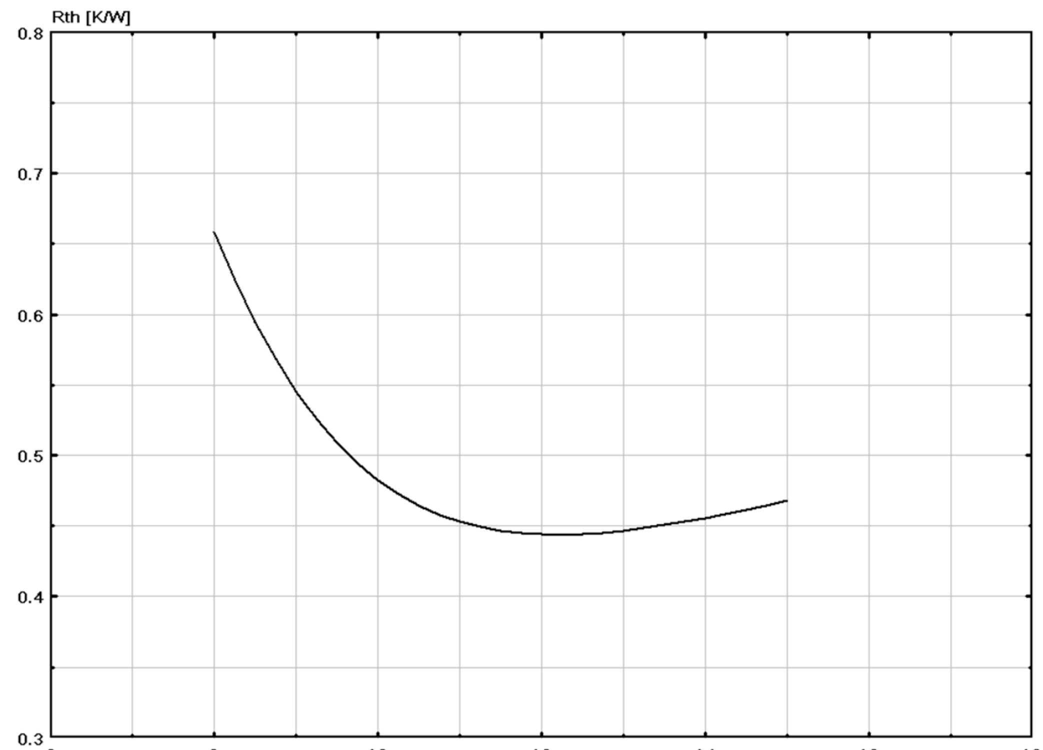

Fig1. Heat sink cross section 350x50, extrusion length 150

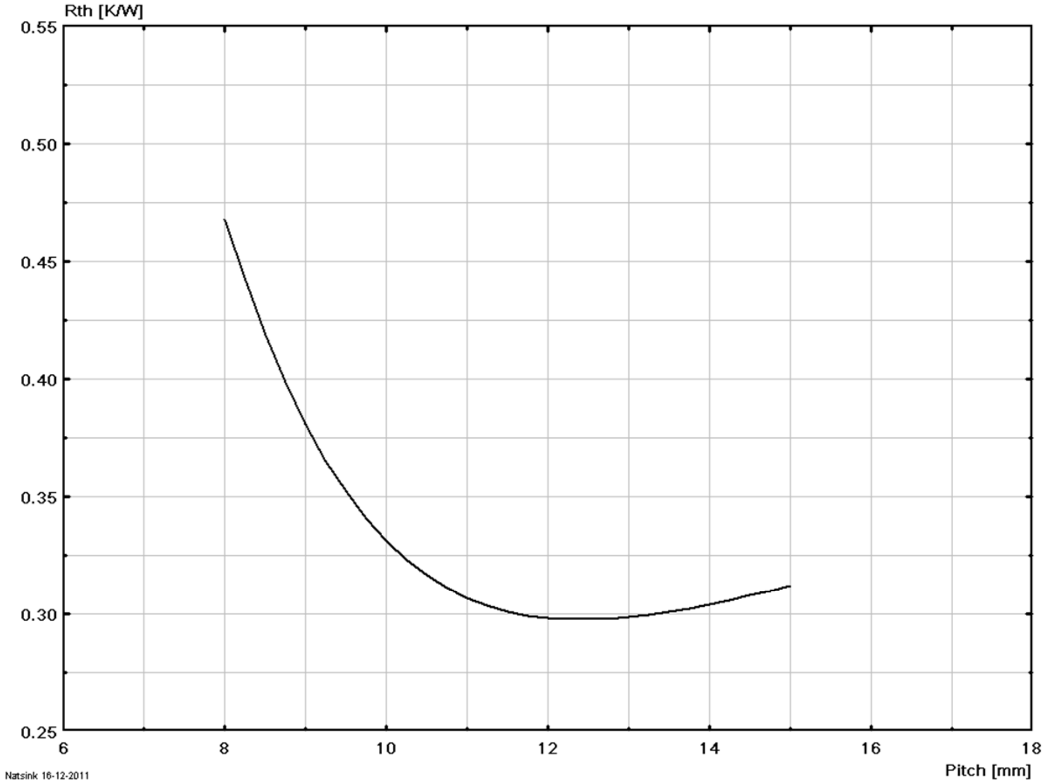

Fig 2. Heat sink cross section 400x60, extrusion length 175

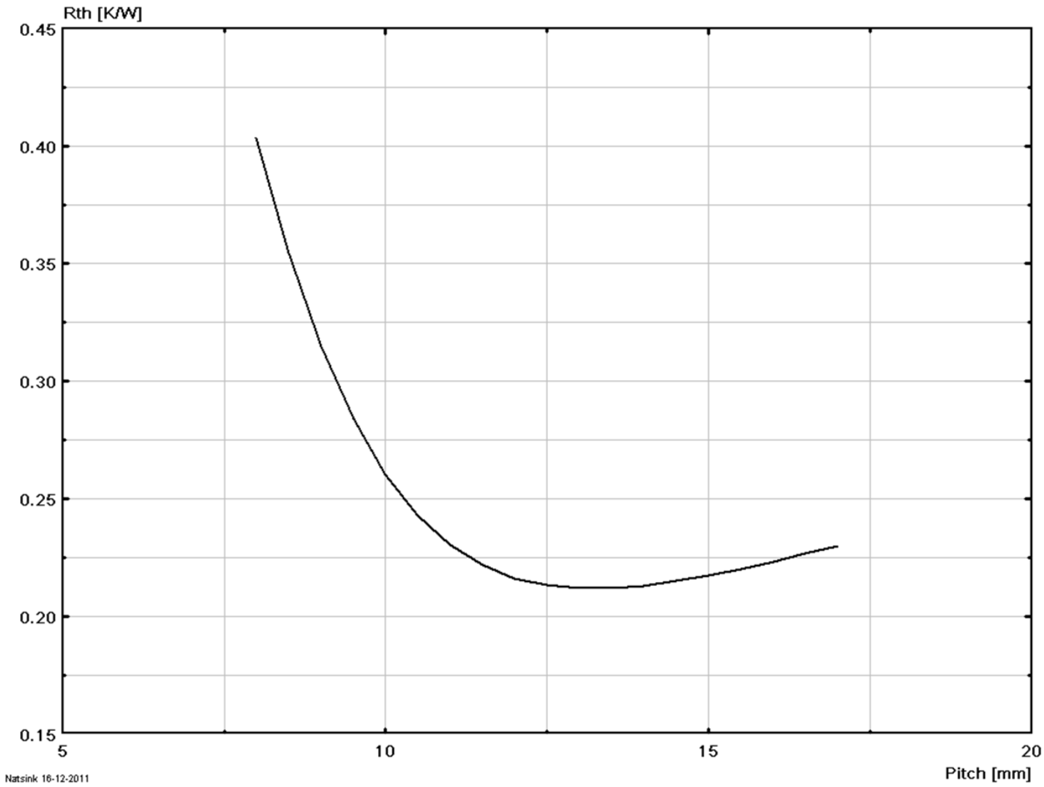

Fig 3. Heat sink cross section 450x75, extrusion length 200

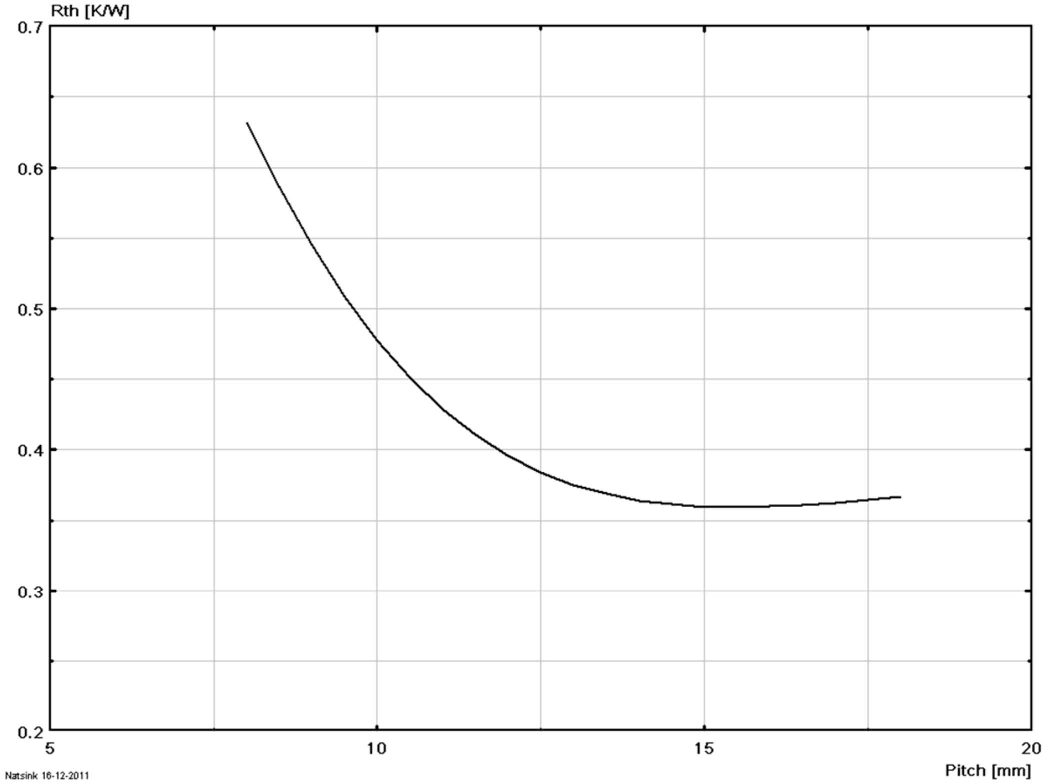

Fig 4. Heat sink cross section 300x40, extrusion length 375

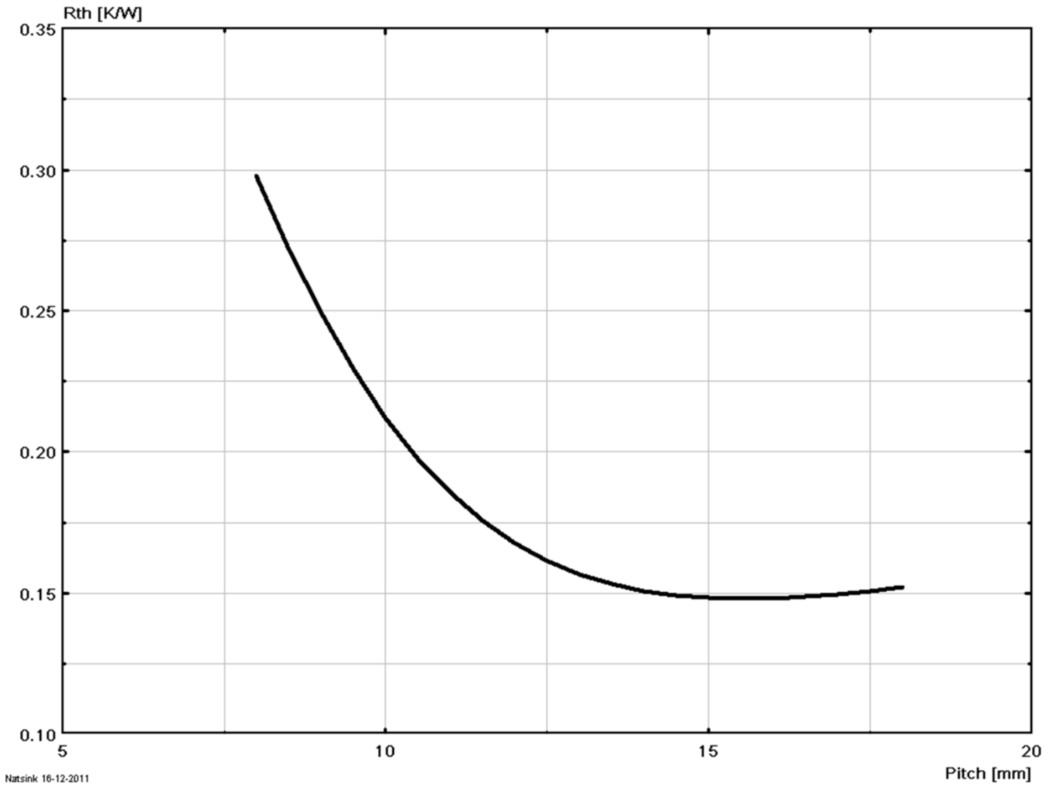

Fig 5. Heat sink cross section 420x40, extrusion length 500

Since the series of calculations always show an optimum fin pitch for a given extrusion length, we can also establish a relationship between the extrusion length and the optimum fin pitch. Here is a plot of the two parameters using a typical heat sink cross-section of 400x50mm :

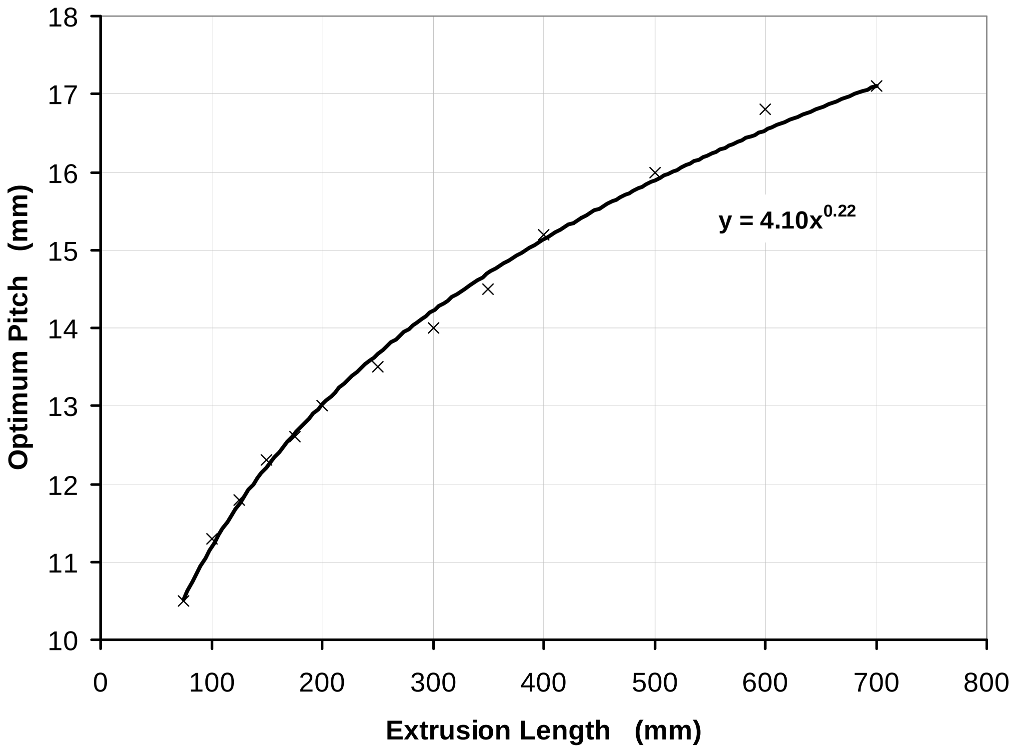

Fig 6.   Optimum fin pitch vs. extrusion length

One can simply this further to an empirical equation for aluminium heat sink extrusions, black anodised with natural convection and radiation :

Optimum Fin Pitch = 4.10 x (Extrusion Length)$^{0.22}$

For example, in a tower monoblock case design with an extrusion length of 375mm, the optimum fin pitch should be 15mm. If the exact pitch is not available, it is better to go for a larger pitch rather than smaller, i.e. 16mm preferred to 14mm, as illustrated in Fig. 4.

References

1. http://frigprim.x10.mx/online/natconv_heatsink.html