Research Articles

AN OVERVIEW OF CAST HOT PRESS FORMING DIE MATERIALS

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In the automotive industry, die life is an important factor due to its high cost and involvement in production lost, die blocks fabrication, maintenance and handling. Die materials require high thermal conductive properties to produce fast cooling of components. Major problem lies on die materials lifetime due to reduced thermal wear resistance when repeatedly heated and cooled.

Though die materials can withstand high working temperature, when exposed to high temperature of above 600°C, the dies will easily wear. During hot press forming (HPF) processing, austenitized blanks were formed and cooled simultaneously between the upper and lower part of the dies. Austenizing of blanks at 950°C temperature before forming and simultaneous low cooling temperature was to allow high formability parts and produce high strength steel with martensitic structure respectively.

However, a vast temperature difference between blanks temperature of 950°C and 5°C chilled water flow within cooling channels to cool down the blanks caused dies to easily fail after few thousands of cycle. Due to this cyclic thermal exercise, die easily wear, cracks and experienced heat checks on its surface.

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Current scenario in local automotive industry is the utilisation of high thermal conductivity steel (HTCS) tool steel range for HPF die which can exhibit high thermal conductivity and consequently produce rapid cooling during forming. Establishment of HTCS tool steel involved costly powder metallurgy method. Besides, being very expensive, HTCS tool steel is unreachable within the local market.

The global market for this HTCS tools steel are closely controlled, monopolised in terms of pricing by three companies namely Rovalma, STM Stahl and Ellwood Specialty Steel. The weakness of HTCS tool steel is its lower toughness and hardness relative to cast steel due to powder metallurgy method used.

Properties of cast Fe-based alloy with laser surface modification relative to Rovalma HTCS 150 [12], as-forged Toolox tool steel [13] and cast tool steel [1] are given in Table 1.

Properties	PM Rovalma HTCS-150 [22]	As-forged Toolox tool steel [23]	Cast H13 tool steel [24]
Density, $\times 10^3 kg/m^3$	7.97	-	7.64
Hardness, HRC	65	45	52 - 56
Toughness, J/m^2	58.341	30 - 80	n/a
Thermal conductivity, W/mK	47 - 66	31 - 34	25.6 - 29.4
Thermal expansion coefficient, $\times 10^{-6}$ / K	10.5 - 14.3	13.5	10.8 - 13.5

Table 1 : Properties of powder metallurgy Rovalma HTCS-150, as-forged Toolox tool steel and cast H13 tool steel.