

Advanced Wax Pattern Materials for Turbo Wheel Manufacture

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Agenda

- A basic overview of wax injection and the need for change
- Characterisation of material setting behaviour
- Dimensional improvements within the process
- Summary

Wax Pattern Manufacture – Typical Overview

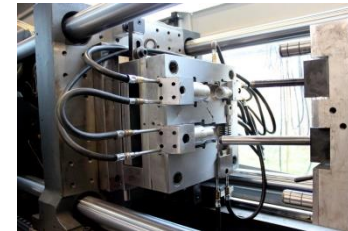


Wax Pellets

Loaded into injection unit



Injected under high pressure into metal mould

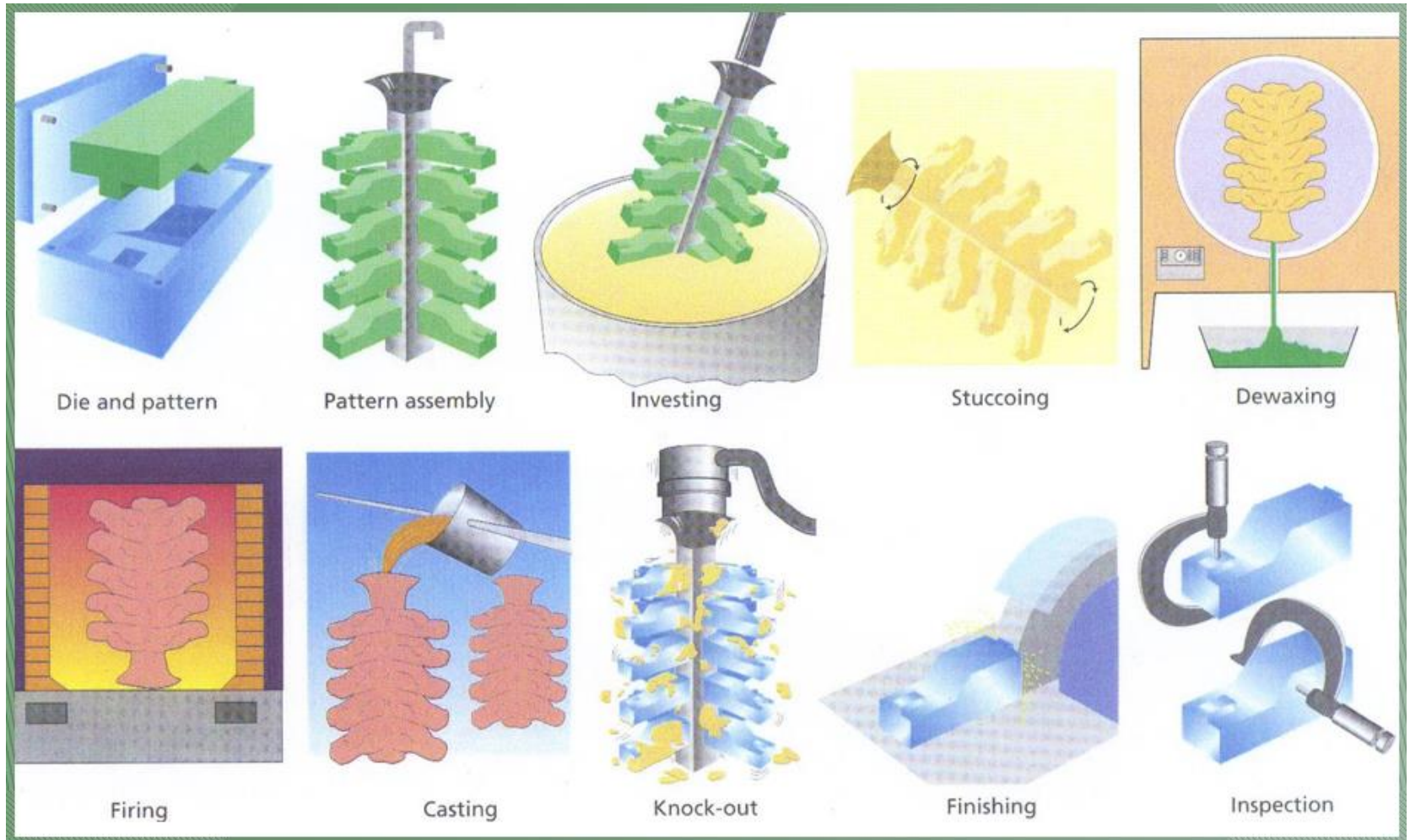


Typical cycle time
25 seconds

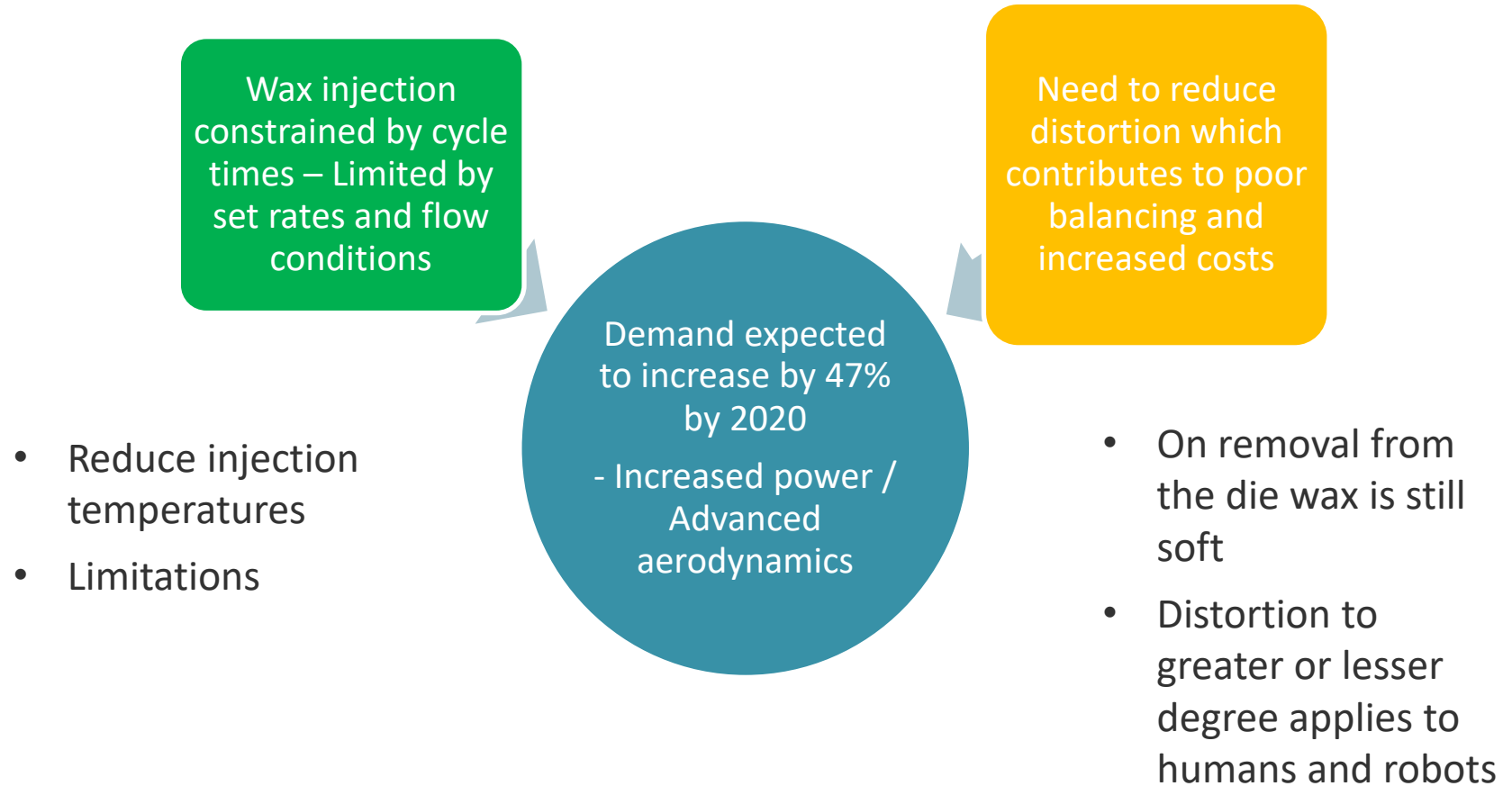


A number of these injected parts are assembled either manually or by automation onto a tree

Wax Pattern Manufacture – Typical Overview



How to Improve Efficiency of Turbocharger Wheel Manufacture?



Wax vs Plastics



Wax

Pros

1. Very fluid – Can make fine detail
2. Works well with investment casting process
3. Ability to recycle – Reduced costs
4. Low ash – Reduced inclusions

Cons

1. Poor thermal conductivity – Longer set times
2. Can distort on removal from die – Dimensional variability

Wax vs Plastics



Plastics

Pros

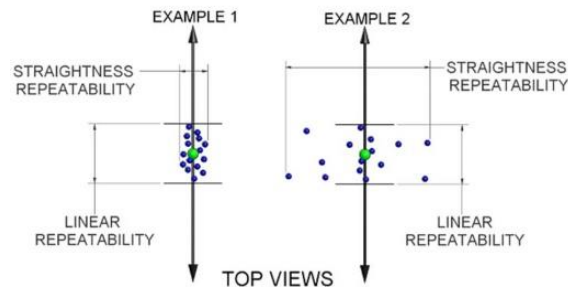
1. Good dimensional accuracy – Minimal distortion
2. Rapid injection times

Cons

1. Specialist high pressure machinery required
2. Not as fluid – Issues with fine detail ?
3. Difficult to remove from ceramic shell – Have to be burned out
4. Don't always lend themselves to recycling
5. Can be issues with ash

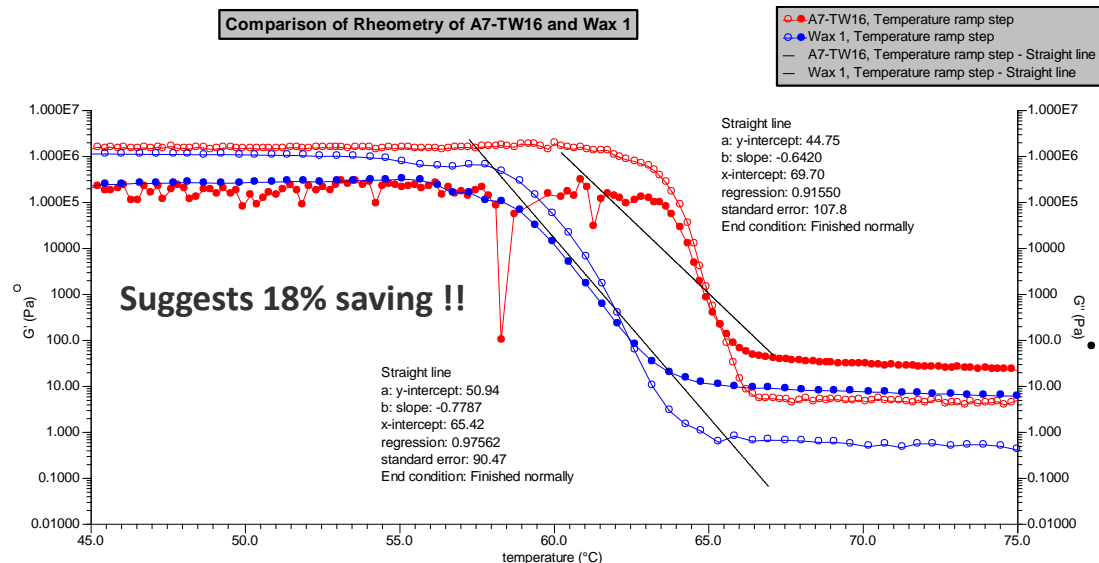
The Hybrid – (A7-TW16)

- A material which has a **semi plastic** behaviour
- **Reduced cycle times** – With a typical 25 second cycle time even a 1 second reduction can result in a 4 % increase in output
- The big question.. How do we test and prove both the following
- **Improved dimensional repeatability** – **Current techniques can be subjective**
- **Reduced cycle times**

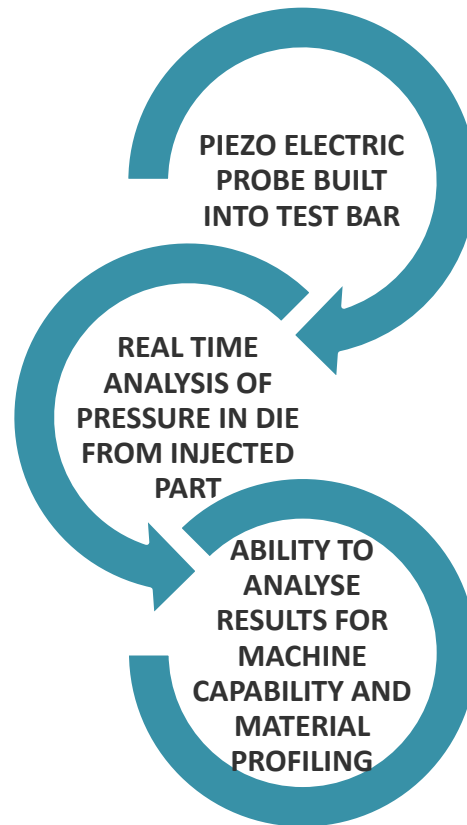


Case Study – Wax Set Time

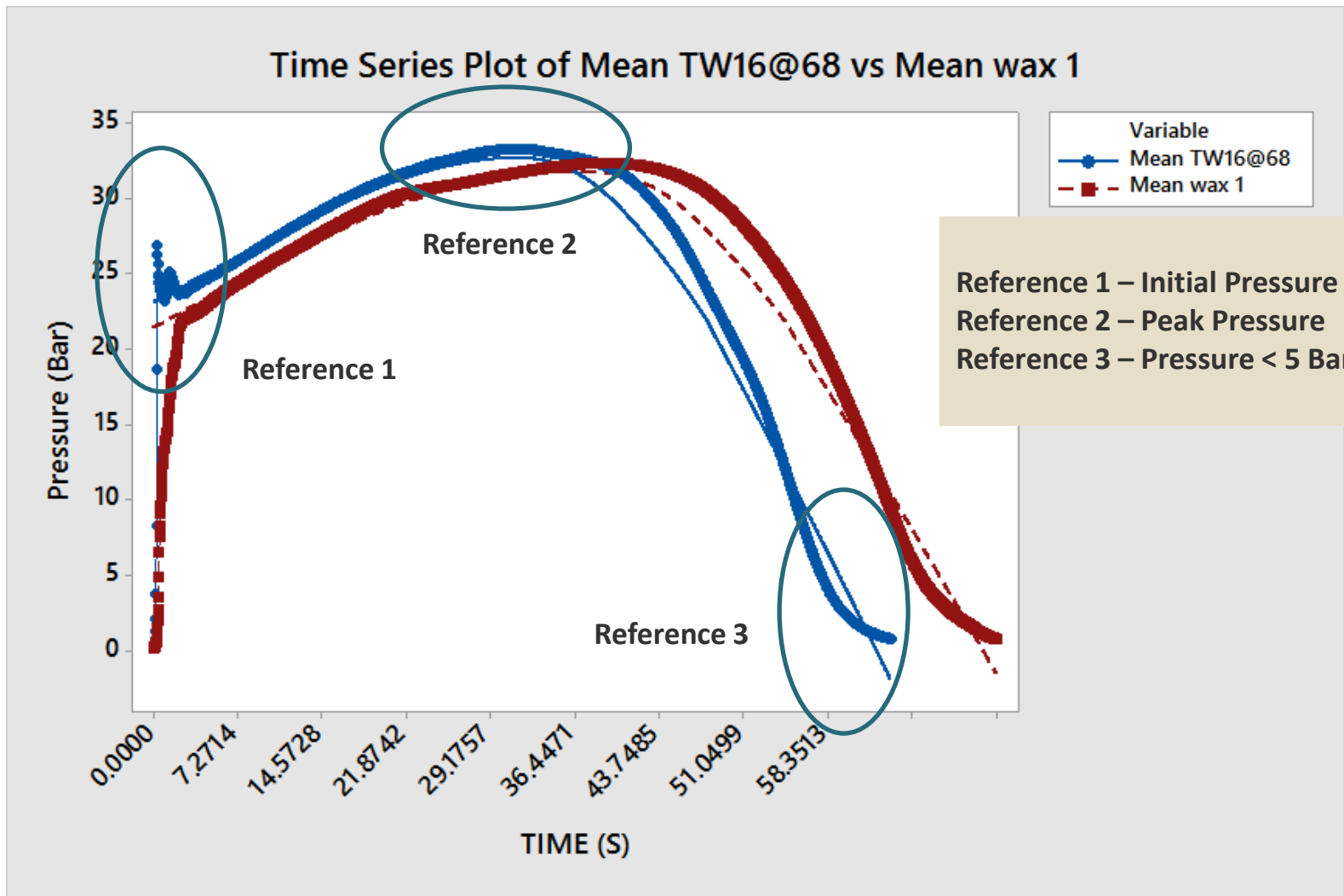
- Assessing set time of wax materials would often involve techniques such as rheometry
- This requires skill to interpret
- Does not give absolute data merely an indication of the setting properties of the material – Does not model injection conditions



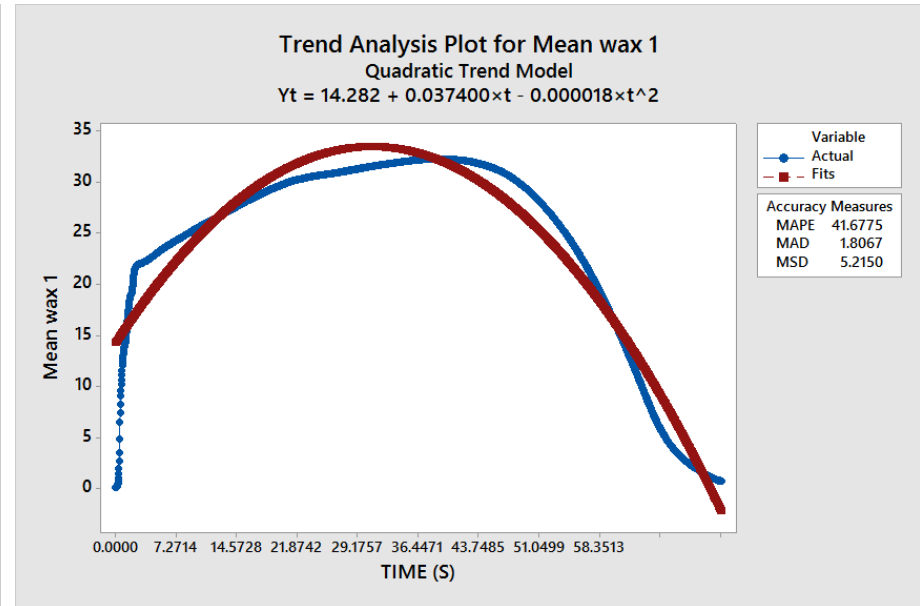
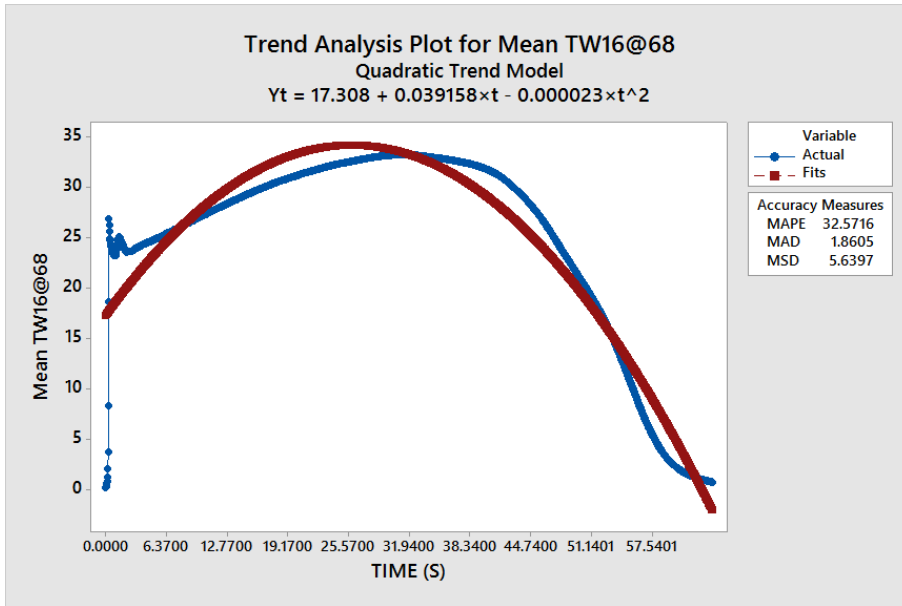
Use of Data Logging



Use of Data Logging

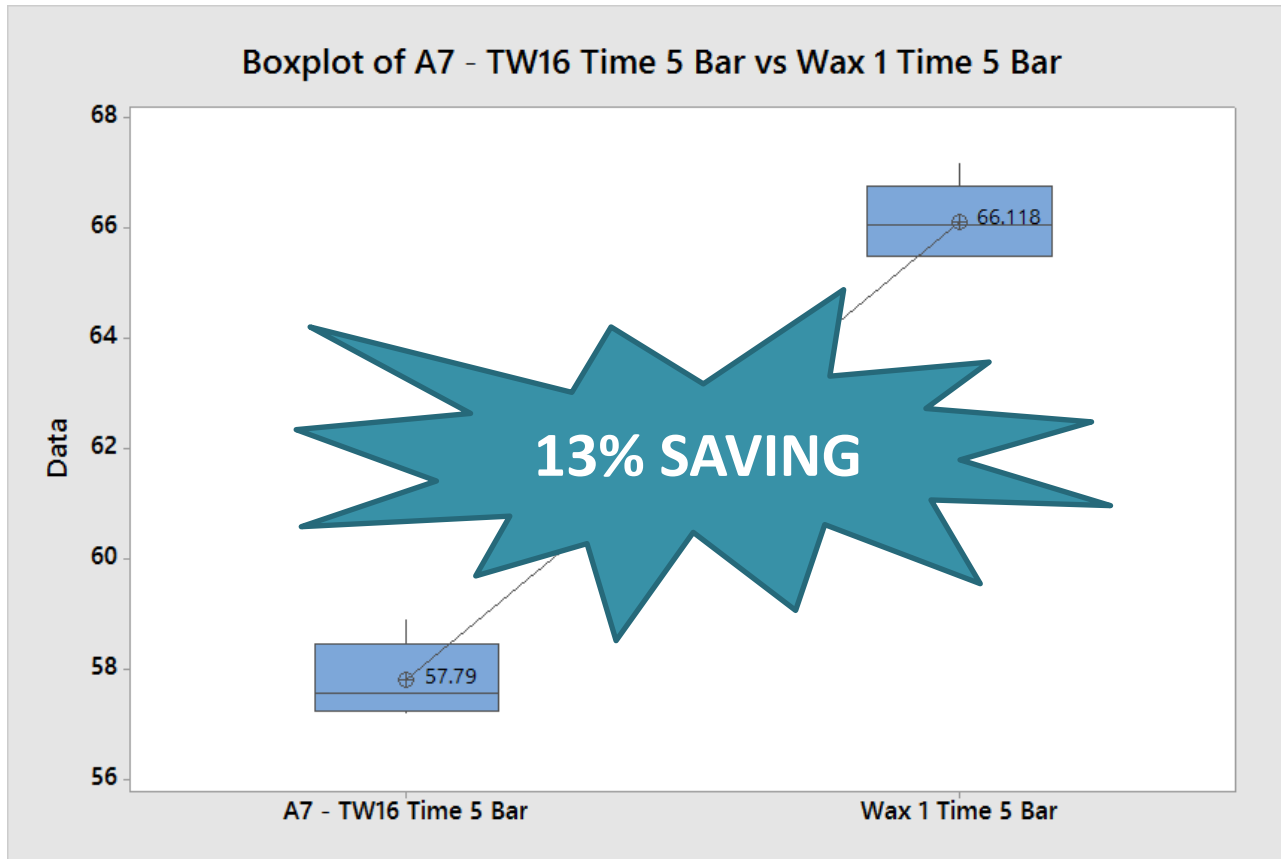


Analysis of Results



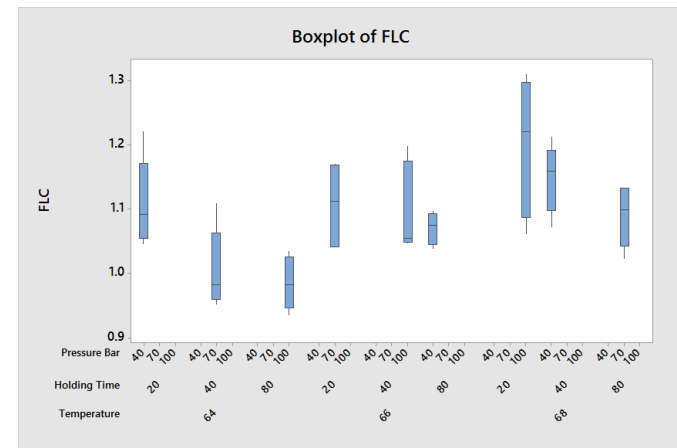
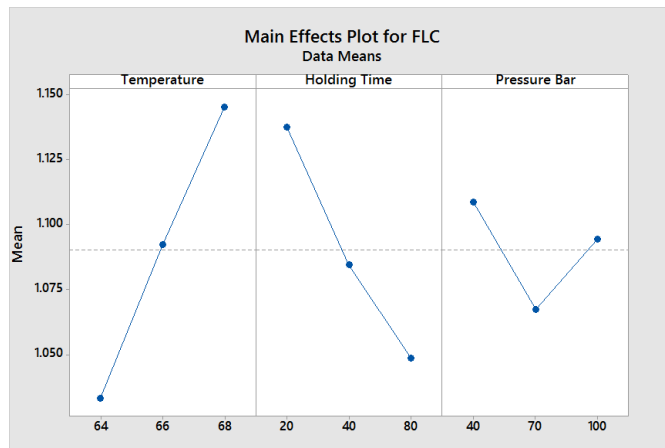
8% SAVING

Analysis of Results



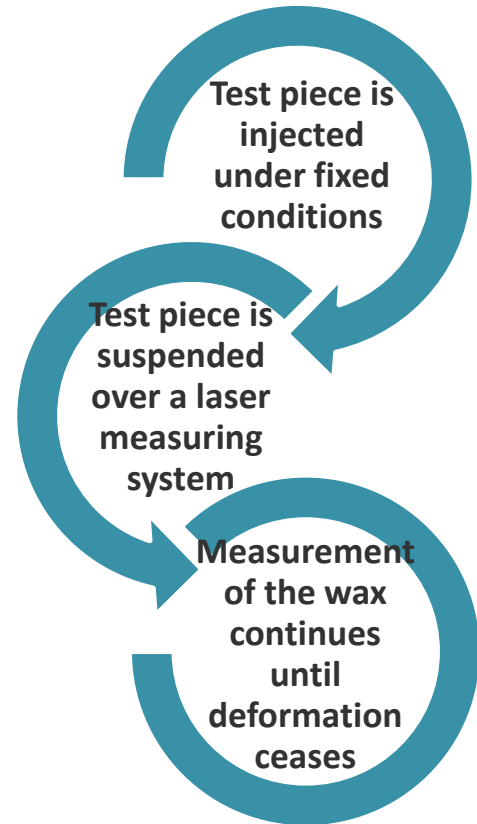
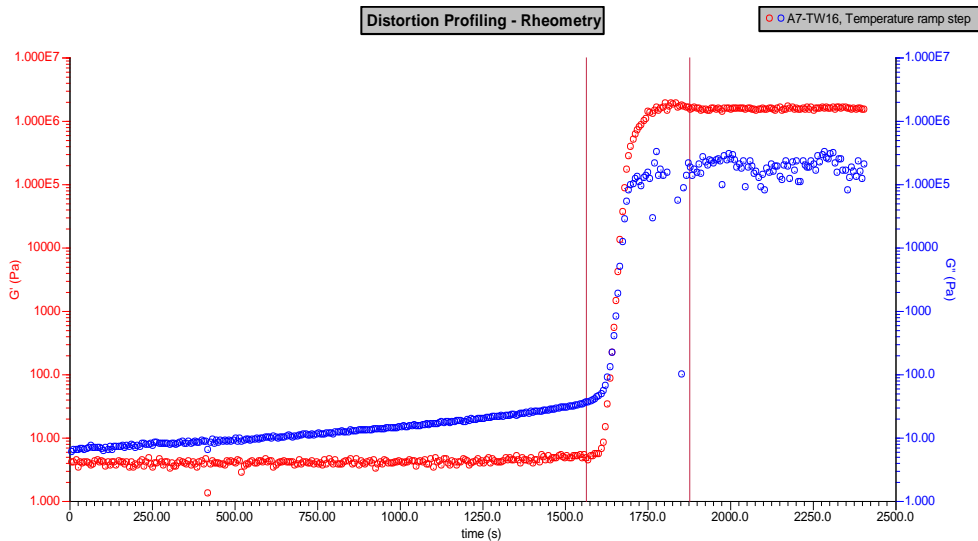
Dimensional Characterisation

- Typical characterisation has been by means of Free linear or restricted contraction
- It is well known that it is affected by injection conditions
- However one key area of dimensional variability is on removal of the piece from the die
- At this stage the wax is still soft and prone to distortion

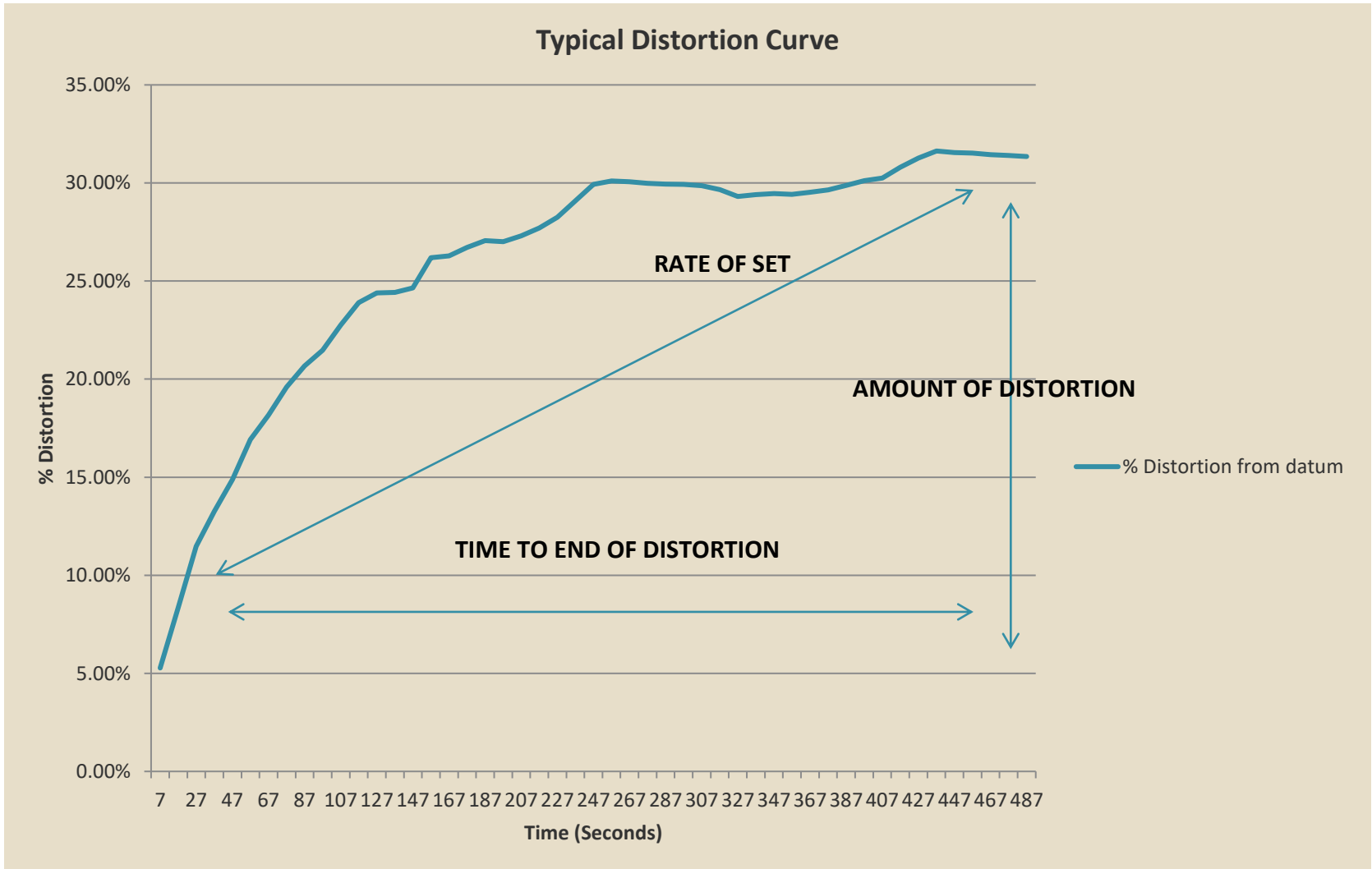


Distortion Test

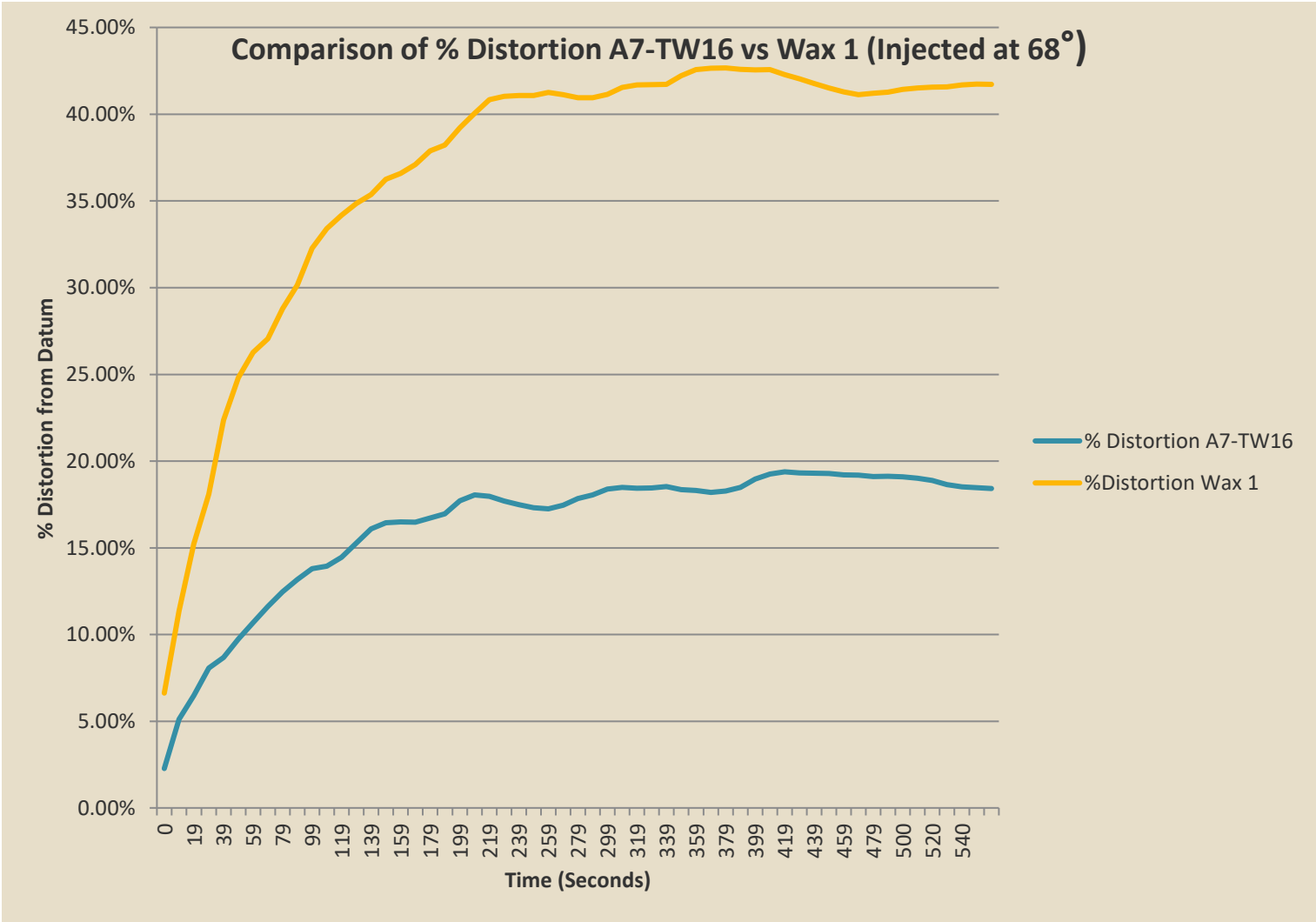
- The aim of the test is to establish both the time and amount a material might distort before it has sufficient rigidity



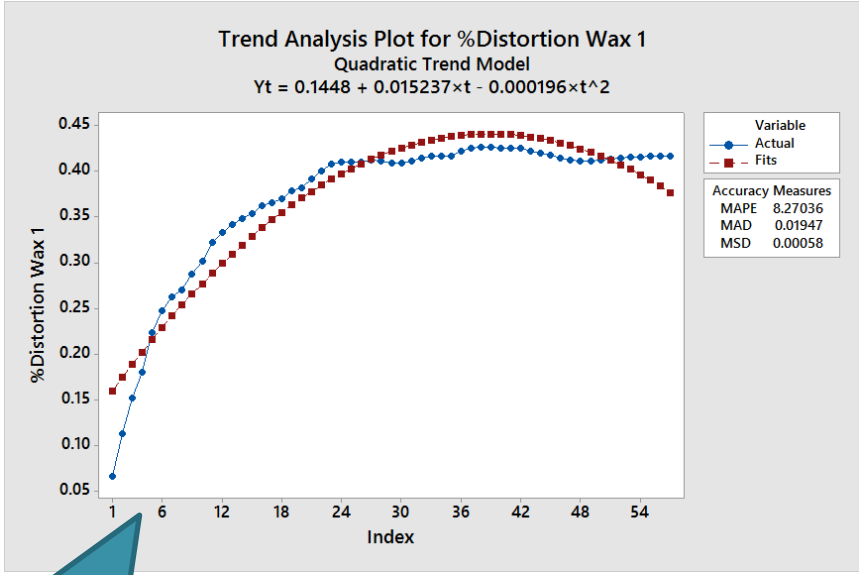
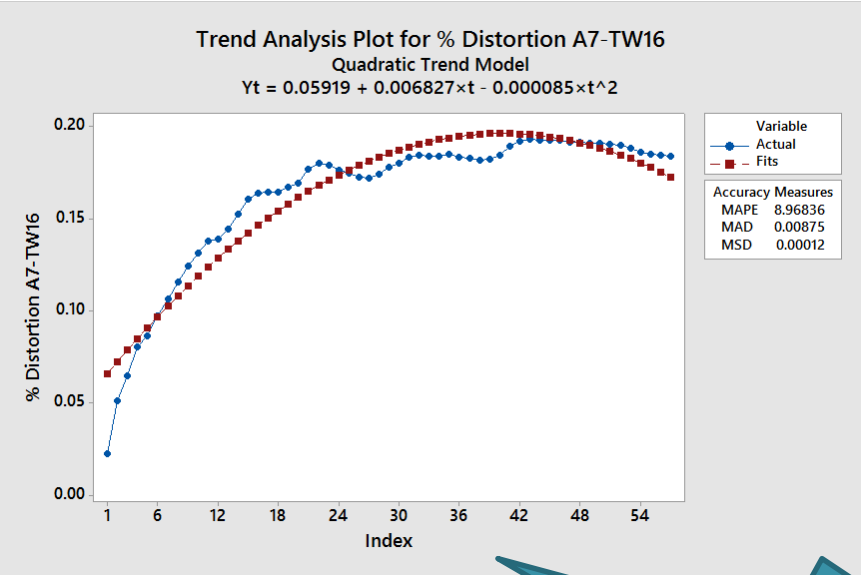
Distortion Test



Distortion A7-TW16 vs Wax 1



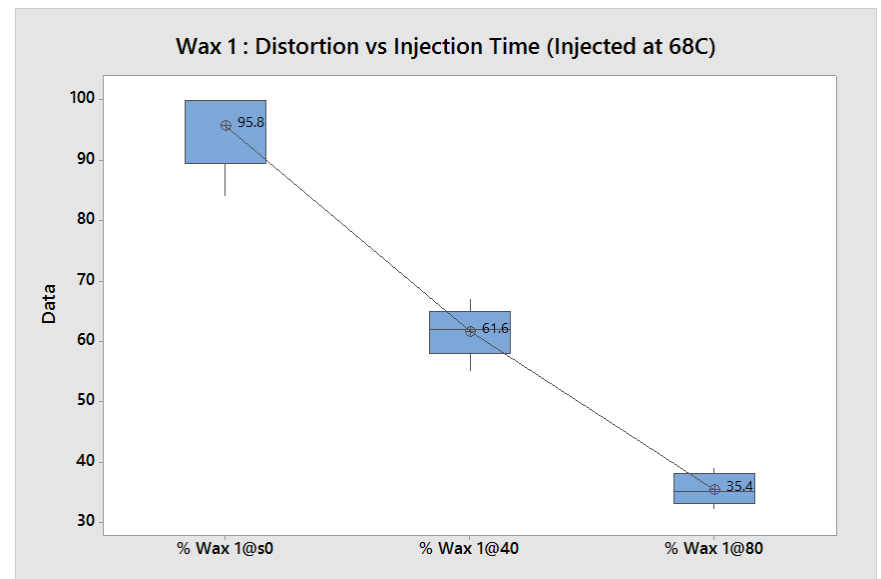
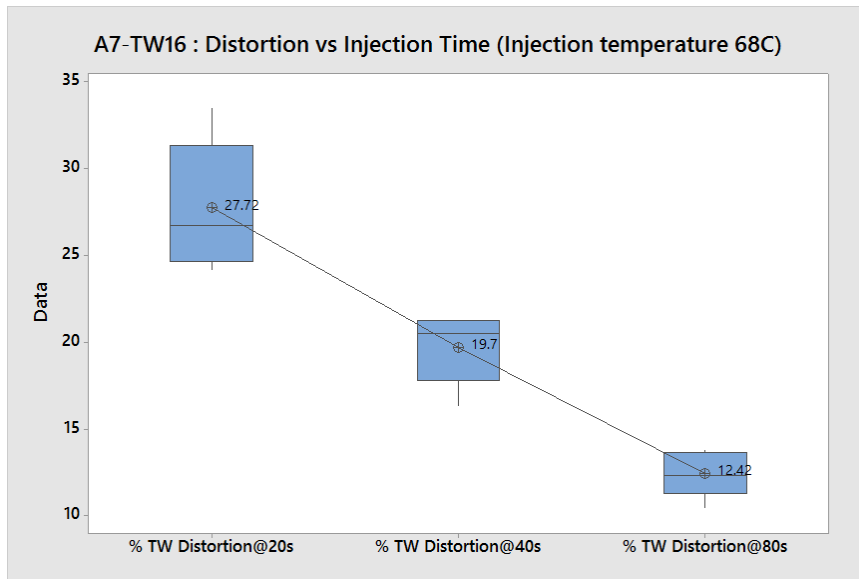
Distortion A7-TW16 vs Wax 1



12 % FASTER SET

Distortion A7-TW16 vs Wax 1

	Time to Zero Distortion (Second)	% Total Distortion
A7-TW16	489 (12%)	19.13 (55%)
Wax 1	546	42.67



Summary

- There is a requirement for improved productivity and reduced costs resulting in a need to engineer improved wax materials
- Although materials such as A7-TW16 offer that possibility, standard test regimes are at best subjective and fail to offer relevant information for Process Engineers
- Injection profiling has shown that A7-TW16 sets around 13% more quickly than Wax 1, an industry standard wax
- Dimensional profiling has proven that A7-TW16 even with half the current injection time is effectively 50% more capable than Wax 1, and at similar times 65% more capable thus reducing balancing requirements due to distortion of the pattern

Thank You

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