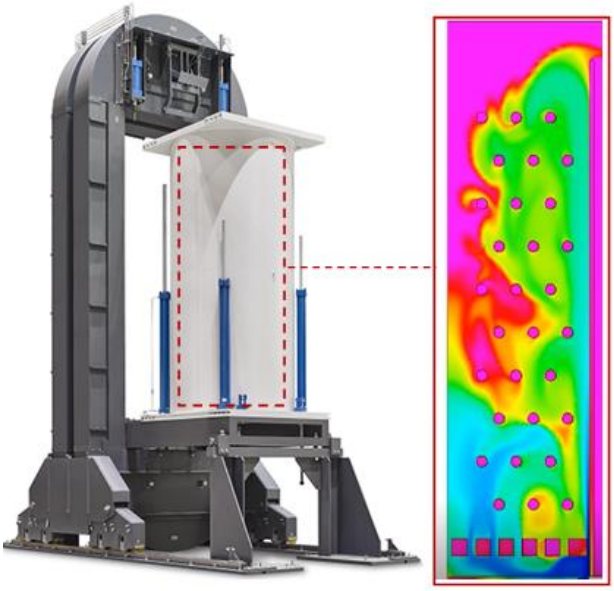
Modelling of mitigation of distortion by Quintus URC®/URQ®



If you are interested in Advanced Material Densification (AMD), novel material systems, and next generation technical solutions brought to the industry by the world-leading company in high pressure products then you should apply for this master thesis! Quintus Technologies develops presses with extreme pressure and temperatures used for processing of todays and tomorrow's materials, and with this research and development work you will drive forward the advancement of press capabilities and broaden end application use.

Background

Our products are built on a history of industry leadership dating back to the early 1960s when we developed the first commercial Hot Isostatic Press (HIP). Today, Quintus's technological innovations have expanded HIP-processing parameters to encompass higher pressure and temperatures with unmatched control, and increased capacities. We develop products from research sizes up to the world's largest HIP production systems.

Range of different HIP systems manufactured by Quintus

Hot Isostatic Presses employ pressurized heated gas for consolidation, densification, or bonding of high-performance components and materials. Processed parts can achieve 100% of maximum theoretical density, resulting in exceptional resistance to fatigue, impact, wear and abrasion. The products from the presses are used in a wide range of industries, with applications ranging from plane bodies, aviation engines, car engines, human-body implants, to critical components used in oil and gas. To obtain superior and

reliable material properties the HIP operates under extreme conditions with pressures reaching up to 3100 bar and temperatures of up to 3000°C. The combination of such extreme conditions and vessel sizes reaching more than 2 meters in diameter and more than 4 meters in height results in massive amounts of stored energy. In fact, at these temperatures and pressures the ideal gas law no longer applies!

The furnace is the heart of the HIP system and Quintus provides state of the art furnace design with a wide range of styles, hot zone materials and advanced temperature measurement techniques. Quintus have developed its exclusive Uniform Rapid Cooling (URC®) furnace that uses either an ejector or a variable speed fan to circulate cooler gas uniformly throughout the work zone. Today this is the state of art for customers demanding uniform cooling of their products for productivity and performance benefits. Quintus continued to push the boundaries for HIP with the introduction of production scale Uniform Rapid Quench (URQ®) systems in 2017, and the introduction of a new generation of forced convection furnaces in 2019. These product advancements are the next steps for broadening the use of HIP in new application segments. To meet future market demands, technological advances in HIP are creating a new generation of applications, which needs further development of the furnaces but also application support and testing.

Task description

By using URC® and URQ® less part distortion can be achieved in comparison to conventional commercial systems not using gas medium, for example oil quenching. The highly pressurized gas in the HIP enables high cooling rates to be achieved, in fact the quench speed by the URQ®-system has been shown to be equal to or greater than oil quench. Yet less part distortion is observed which raises many questions related to the mechanisms mitigating such responses. With many HIP-systems nowadays sold to the growing market of 3D printing, this opens a new method where advanced geometries and material combinations can be produced. We therefore suggest a project aimed to investigate the difference in distortion between Quintus HIP systems and other conventionally available equipment. The aim is to evaluate distortion and crack behavior for more complex geometries and materials used in 3D-printing by modelling and compare against experiments from our lab and other commercial systems in collaboration with participants from a world leading research institute and industrial participants from the aerospace industry. As demands from the costumer increases advanced tools must be used in this process. One such tool, that is nowadays quite commonly used, is CFD. The challenge is, however, to perform efficient and trustful simulations on complicated problems. The aim is to investigate the cooling process on several different parts and one key interest is the temperature gradients in the load during the cooling.

The objective in the project is to examine the cooling and distortion and crack behavior of both simple and complicated components with the means of CFD/FEM. The main tasks will be:

- Transient analysis of the flow field around and conjugate heat transfer to components in the furnace
- Distortion of the geometry
- Validation of the results against experiments
- Comparison to other quench methods

The intention is that the work shall be the groundwork to find new application areas on to which the HIP technique and our new patented furnaces can be used. The thesis will give a clear view of the pros and cons with the commercial systems on the market.

Suitable background

- Master of science program in Mechanics, Physics, Mathematics or similar
- Skilled in fluid dynamics and numerical analysis
- Accustomed with CFD/FEM products

Application information

The thesis will take place at Quintus office in Västerås and is aimed for one person. The results will most likely be published in different market channels after the thesis is finished. The selection will be ongoing so therefore apply as soon as possible. Send your CV together with grades to Per.

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For more information about our products please visit our homepage at http://quintustechnologies.com/. Also feel free to follow us on LinkedIn or watch our latest videos on our YouTube channel https://www.youtube.com/channel/UCkWs8iqIGhjrIvfTkl98CbA. In the figure below can a schematic description of the cooling be seen to the left; the flow generator can be either an ejector or a fan or a combination of the two. The middle figure shows cooling of load inside a furnace and the right figure shows cooling of a single component using CFD. For a video of AM and HIP we can recommend https://youtu.be/tIimlMAVlZA, Quintus work in close collaboration with customers in the Space and Formula 1 business that rely on our knowledge to maximize performance of their products. Some of our deliveries can be seen in our newsfeed at https://quintustechnologies.com/news/.