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## 100 years of high vacuum with the vapour diffusion pump - from mercury to oil and back

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The mercury vapour diffusion pump was the first pump that allowed to reach high vacuum conditions. It was invented in 1915 by Wolfgang Gaede (1878-1945), who later became Professor of Physics in the Technical University of Karlsruhe, Germany.

Until the mid 60s, vapour diffusion pumping remained to be the prime high vacuum pump technology, but was then more and more replaced by cleaner vacuum pumps: cryogen-free cryopumps using Gifford McMahon closed compressed helium cycle cryocoolers, and, most of all, by turbomolecular pumps (invented in 1958). But even today, oil vapour diffusion pumps do feature an interesting combination of robustness and high speed pumping over a wide pressure range, in particular when equipped with additional ejector nozzles (booster or jet configuration). This is the reason that they are still used, in particular in applications with high contamination loads such as metallurgy and vacuum ovens.

Interesting enough, a novel development has started recently in Europe towards a mercury diffusion high throughput pump system for nuclear fusion, driven by the fact that mercury is perfectly compatible to the nuclear fusion fuel, whereas oil or hydrocarbons are not.

This paper starts from Gaede's initial pump design and describes the main improvements and modifications the mercury diffusion pump has seen. Then, we address the change of the operating fluid to mineral and synthetic oil and outline the design features that have been developed and integrated until the stage of the modern oil vapour diffusion pump. Finally, we highlight the case for a new mercury diffusion pump for nuclear fusion. First results on this development path will be presented. This novel application of a historic technology was also the starting point to look into the numerical modelling of such pumps and to start a R&D programme to develop a simulation tool based on modern state-of-the-art approaches.