

CAMX - A High Performance Cutting Technique for Underwater Use

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ABSTRACT

During the past years a new cutting technology, the CAMX-process-family (Contact-Arc-Metal-X [X is for Cutting, Grinding and Drilling]) was developed at the Institute of Materials Science in Hanover. These are electro-thermal underwater separation processes for metallic structures. The CAMX technology covers the Contact-Arc-Metal-Cutting (CAMC) with a sword-like cutting electrode, the Contact-Arc-Metal-Grinding (CAMG) with a rotating electrode and the Contact-Arc-Metal-Drilling (CAMD) with a wrap mechanism to fix and carry the workpiece. There are no limitations of CAMC concerning the capability of cutting complicated structures of workpieces. Undercuts and cavities in the workpiece do not affect the CAMC. The CAMG is a separation process for straight cuts with a very high cutting speed. The CAMD is a technology to drill holes or pocket holes of any geometry. With the integrated wrap mechanism it is possible to fix and carry workpieces, which are not to handle with conventional mechanisms.

INTRODUCTION

The fields of application for powerful underwater cutting techniques are manifold. Among these are applications in shallow water areas, like construction, maintenance and repair of harbour facilities, canals and vessels. Applications in deep water include offshore-installations [1] and salvage operations. Additionally, there are also highly specialized uses, such as in the decommissioning of nuclear installations. The decommissioning of nuclear installations is an enormous challenge because of large material thicknesses and material variety. In small radioactive contaminated rooms, the use of most of mechanical cutting tools is only possible with high application expense. Thermal cutting techniques offer solutions to these problems. They do work without tool guiding forces and thus, guiding machines may be smaller and simpler. The most engaged thermal cutting techniques are underwater plasma arc cutting, Oxy-fuel-cutting and consumable electrode water jet cutting. Mechanical-hydraulic cutting techniques complete these thermal cutting techniques [2]...[4].

During the past years, a new cutting technology was developed at the Institute of Materials Science in Hanover, the CAMX-process family (Contact-Arc-Metal-X). Here, X symbolizes three different variants of the process, i.e. Cutting, Grinding and Drilling. All of these variants are electro-thermal cutting techniques, which cut conductive materials with Joule and arc heating. The electrical arc flame is the result of a short mechanical contact between the cutting electrode and the workpiece. Basic components of those three technologies are one or several DC-welding transformers, powering the cutting devices with required electrical power.

Contact-Arc-Metal-Cutting

Contact-Arc-Metal-Cutting (shortened CAMC) with a sword like cutting-electrode is a thermal cutting technique currently used for decommissioning of nuclear facilities [5]. A waterjetting electrode made up of pure graphite, carbon fibre reinforced graphite or a special tungsten-copper-alloy, melts the metallic workpiece in a cyclic process by resistance heating and a free burning high current spark channel. A Master-Slave-Manipulator leads the electrode through the components, free of tool guiding force. Therefore, the manipulator may be designed relatively simple. With CAMC, all electrically conductive materials can be cut, including stainless steel plated mild steel constructions. The maximum component thickness that can directly be cut depends on geometry of the electrode and the efficiency of the water scavenging.

By this technology, complicatedly designed components like tube-in-tube-workpieces and components with re-entrant angles can be separated within a single cut. State-of-the-art of CAMC is cutting of components with a thickness of 260 mm. The kerfs show widths of 4 to 8 mm and the wastage ranges from 20 to 25%. The latest development is a computerized process control for the feed motion. This process control optimizes the feed motion depending on the resistance heating and the free burning high current spark channel. A special CAMC-tool with a turntable drive unit and an integrated process control for automatically cutting was developed by scientists of the Institute of Materials Science of Hanover.

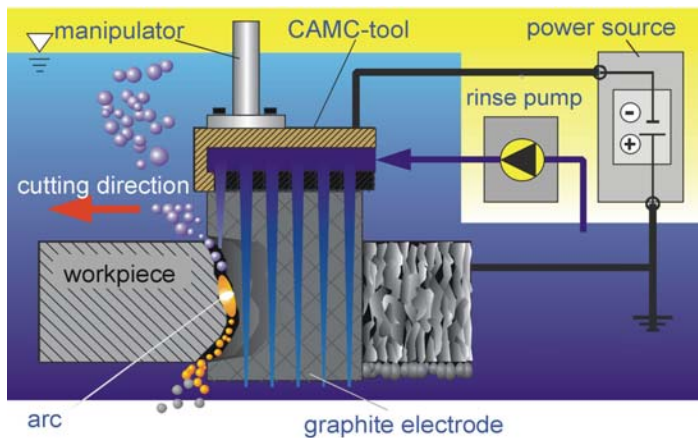
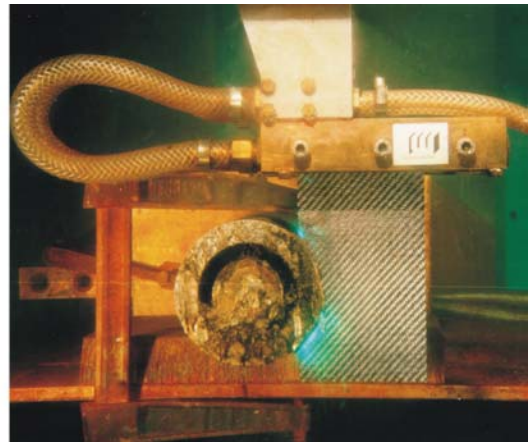


Fig. 1: CAMC-principle and tool



Contact-Arc-Metal-Grinding

Another cutting technique is the **Contact-Arc-Metal-Grinding** (CAMG) with a rotating electrode, offering new fields of application. Here, electric power is transmitted by a special mercury filled chamber within the tool. The maximum electrical power of this tool is 275 kW (5.000 A / 55 V). As materials for the cutting electrode, steel or carbon fibre reinforced graphite can be used. Due to the substantially smaller costs, in combination with comparable cutting performances, steel electrodes are preferred. On principle, there are no limitations of CAMC and CAMG concerning the capability of cutting complicated structures of workpieces.

The cutting speed is very high: For example, CAMG is capable to cut workpieces of 15 mm thickness at a speed of 3 m/min. This can't be reached by any other thermal underwater cutting technique. The wear of the rotating electrode can be reduced to 9% by appropriate parameter adjustments, and the maximum cutting thickness is 40 mm. In the future, it will be possible to cut thicknesses of more than 40 mm.

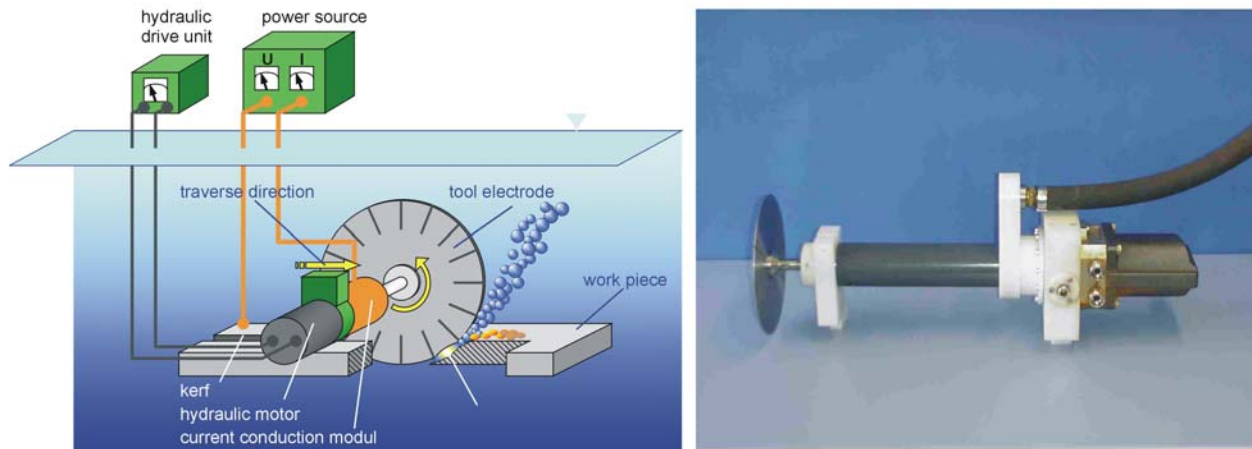


Fig. 2: CAMG-principle and tool

Contact-Arc-Metal-Drilling

The last of the three CAMX-processes is **Contact-Arc-Metal-Drilling (CAMD)**, which was also developed by the Institute of Materials Science in Hanover. CAMD is a novel technology to drill holes or pocket holes without restoring forces. In the CAMD-tool, there is a warp mechanism to fix and carry the workpiece. At first, a rectangular countersinking graphite electrode produces a drill hole. After that, the drilling mechanism makes a turn of 90° and a hydraulic warp mechanism fixes the workpiece. Subsequently, the workpiece and the drilling tool can be carried away.

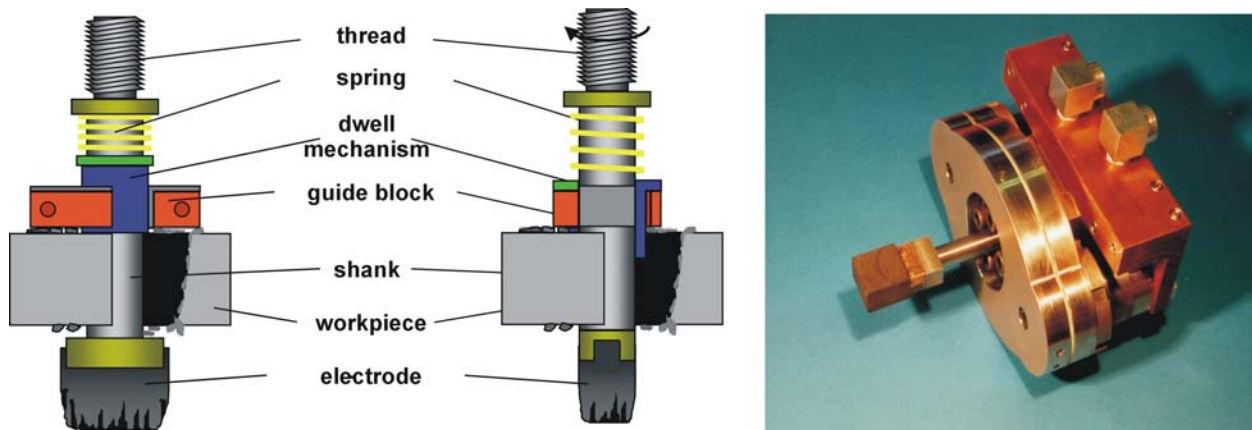


Fig. 3: CAMD-principle and tool

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