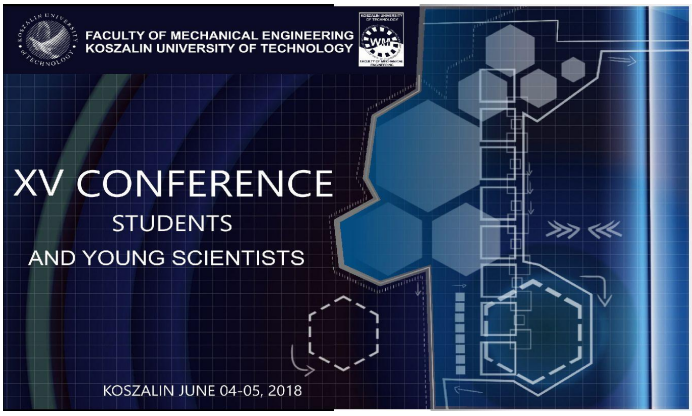

Advantages of the chipless bores manufacturing – an overview of friction drilling applications

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ABSTRACT. This article is a synthetic collection of information on the benefits of using a non-sparking method of making holes. The first part presents the method of friction drilling. Tools, machines and machinable materials used. The benefits of this method are set out below. The results of tests on changes in materials processed with this method are analyzed. The influence on the durability of materials as well as changes in their structure is discussed. Advantages in terms of litigation costs are identified. The ecological aspect as well as the process friendliness for its operators are discussed. The final section identifies the industries and possible applications of the frictional drilling method in the industry.

KEY WORDS: friction drilling, thin materials, construction, hydraulics

1. Introduction

Thermal drilling (also known as thermoforming or thermal drilling) is an innovative technique for making threaded connections and perforations of metal materials with a thickness from approx. 1 mm to 12 mm, as an alternative to, inter alia, nitro-nuts, welded nuts, sealed nuts, pressed and screwed nuts and other joining techniques. During machining, a medium length sleeve corresponding to 3 to 4 times the thickness of the material is produced (Fig. 1) [4]. The process begin when the conical part of drill contacted with machined material. Friction cause that the temperature is increased. Lots of heat makes the material plastic. When machined material reach plastic flood temperature then axial feed cause the bore is created. Material is formed around the rotating drill [7].

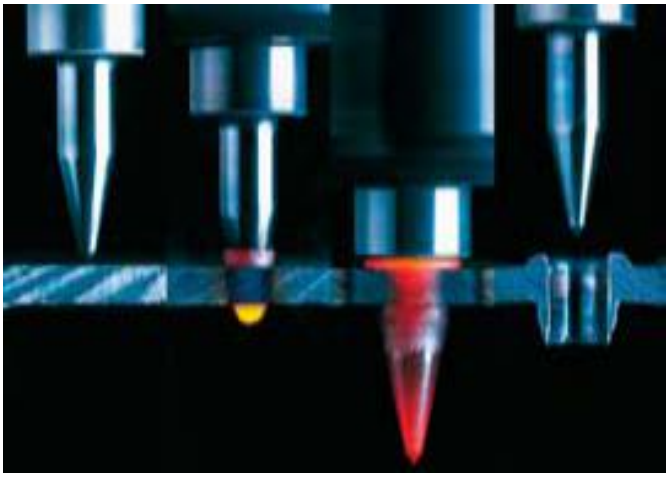

Fig. 1. Thermal drilling process scheme [1]

Coated carbide are mainly materials used to drills manufacturing. High hardness is main cause why they are used. This property is significant because high temperature could caused degradation of drill surface and can be cause of chemical changes between drill and machined material. Low influence of adhesion forces is really important when stainless steel or light metals alloys are machined. This solution provide preventing the material degradation like corrosion [3].

Drill construction and used material let to make over 10000 bores with one tool. That's make this tool much more durable than conventional tool used to chipboard machining [6].

2. Main Advantages of the chipless bores manufacturing

From many points of view, making bores using the friction drilling method has features that place this process above the process of conventional drilling. Before this method was popularized to make the threaded connection in thin walled material then was needed few operation. Machined material was moved between different workstand like drilling, welding or montage (if nitonated nuts was used). This methodology generate costs and increased manufacturing time lenght. Thermal drilling is a cheaper and faster process than traditional methods of drilling. This method requires only two operations to make a threaded hole (Fig. 11). And those operation can be make on the same machine with one worker [10].

This kind of threaded connection have few advantages above older methods. Durability can be indicated at first. This type of thread of sheet metal and thin walled material can be used many times. Often is that nitonated nut losts own properties with cycles of screwing in and out . Then replacing is needed what could be problematic for the product's final user . From other side welded nut is technique which generate many lacks in production process. Errors with position or neccesary of thread calibration after nut welding makes this process much more expensive [1,2,8,9].

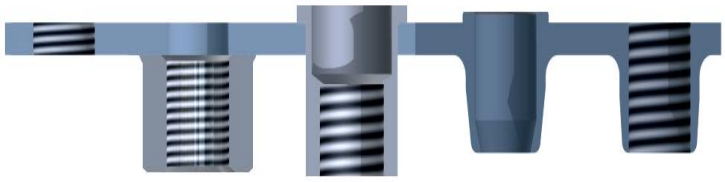

Fig. 2. Methods of threaded connections in thin materials manufacturing [11]

The materials that can be subjected to friction drilling are a very heterogeneous group. Such a wide variety of materials allows this method to be used in various applications. The basic groups of materials to be machined can be identified:

- structural and ordinary steels;
- alloyed steels (stainless and acid-resistant);
- non-ferrous metals and their alloys (bronze, brass, aluminium alloys).

Each of these groups of materials has different physical and mechanical properties, resulting in different energy requirements to induce plastic deformation of the material. As a rule of thumb, workshop practice has shown that the lower the hardness of the material, the higher the spindle speed should be [10].

Friction drilling as a process of chipless machining also causes that the holes made are characterized by much higher strength parameters than those made with the use of cavity techniques. The material is only formed around the tool, which results in a compaction of the material structure, which leads to its strengthening in the machining zone (Fig. 3) [3].

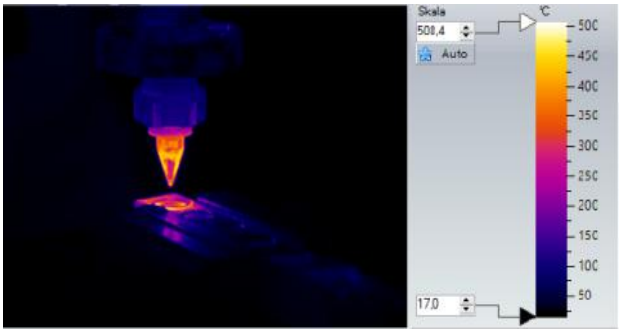

Fig. 3. Thermal drilling process thermogram [11]

Friction drilling affects the material with a small thermal change zone (heat affected zone), due to the fact that the tool absorbs a significant amount of heat, and does not disperse it in the drilled material. Not only drill take off heat from process. Special kind of mount causes air move. The move direction is from machining zone up. This solution causes faster cooling of material and drill. Furthermore cooling discs prevent for increasing temperature to phases changes level in material. The colour of the material retains a homogeneous shade, which additionally shows that the heat generated by friction is absorbed evenly (Fig. 4) [3].

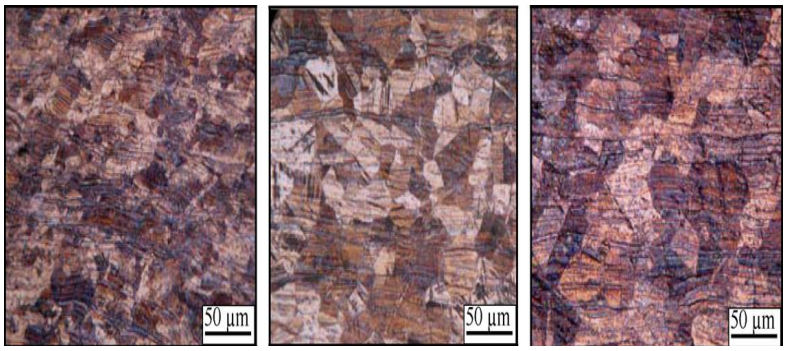

Fig. 4. View of the change in the structure of AISI 304 stainless steel as the distance from the edge of the drill hole increases (from left: 0.2 mm; 1 mm; 3 mm) [3]

One of the factors that reduces costs and the time needed to shape a hole is the fact that no coolant is used. This has a significant impact on the environment as well as on the worker's working comfort (lack of oil vapours). Moreover, the fact that the workpiece does not need to be cleaned from chips or liquid remains is a great advantage, especially when shaping openings in closed profiles or tanks. The high degree of purity of thermal drilling allows this method to be used for making holes in structures intended for medical applications or those in contact with food [10].

3. Overviev of friction drilling applications

Simplicity and low cost effectiveness are the basis for a wide range of friction drilling applications. This crowding-out method competes realistically with the following pooling methods:

- screw connections, - screw connections;
- soldered and welded joints, - soldered and welded joints, - soldered and welded joints;
- bearing sockets / fits;
- self-tapping screws.

The following applications may be indicated as examples:

- in the construction of handrails, doors, stairs, acoustic panels or balustrades;
- emissions in the automotive industry in body parts, suspensions and exhaust systems;
- in the hydraulic industry (distributors, heaters, heat exchangers, solar panels);

- furniture industry.

4. Conclusions

The information collected during the analysis of the literature sources which are the basis for this article led to the following conclusions.

1. The cost and duration of friction drilling operations is in real competition with conventional drilling.
2. The friction-drilling holes are characterized by the strengthening of the material in the machining zone.
3. Thermal drilling of bores is a more environmentally friendly process than defective methods of making holes.

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