

## The visualisation of manufacturing process of pipes welding

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Received 31.10.2006; accepted in revised form 15.11.2006

### Education and research trends

#### ABSTRACT

**Purpose:** The aim of this paper is to show the concept of application the visualization technique for educational aims. This approach allows enriching a didactic process. Also this technique could help in solving problems consider with analyzing the manufacturing processes.

**Design/methodology/approach:** The presented work bases on the application of computer visualization techniques for elaboration the presentation of chosen manufacturing processes. The computer visualization has been based on films captured in the manufacturing plant.

**Findings:** The main result of this work is the proposal of the methodology of preparing visualization approach. It has been propose some remarks relating to this methodology.

**Research limitations/implications:** The presented elaboration bases on one chosen manufacturing process. As an exemplar it was chosen the process of pressure welding of pipes with currents of high frequency. So the presented process links two main manufacturing processes: the welding technology and the plastic forming.

**Practical implications:** The implication of the work could be found in two remarks. Firstly it is important to introduce to the industry practice the visualization approach as more didactic and which allows omitting some faults generated in a conventional approaches. Secondly this approach could enrich the scope of approaches offered by educational platforms in e-learning systems.

**Originality/value:** The value of this work is its subject. In this work a new educational approach is presented. Secondly, in this work it is presented the analysis of preparing the visualization of a manufacture process. Also some solutions in this area are included.

**Keywords:** Computer aided teaching; E-learning

### 1. Introduction

The presented work includes the analysis of visualization the process of pressure welding of pipes using currents of high frequency. The idea of this work is considered with the development of different forms of e-learning in the area of material sciences. Particularly it refers to the teaching

methodology of manufacturing processes. In conventional approaches it was needed to apply very expensive industrial laboratories or take students to industrial plants to present them main factors of chosen manufacturing processes. This approach was limited also by the specific conditions of the industrial plant. It results in a situation that not all process elements could be shown to the students. Moreover one should remember that some elements of technological processes are dangerous.

After applying visualization techniques it is more effective to conduct an educational process [1]. Students could investigate all elements of the chosen manufacturing process on computer panels. They can examine also some faulty realization of this process what is impossible in a conventional approach.

The other area of application of this approach is the area of technical process planning. The visualization technique allows analyzing the process in a virtual environment and eliminating all faults that are not visible for technology designers [2, 3]. It results in decreasing costs of this phase of a production process.

## 2. The pressure welding technology

The presented in this paper visualization process bases on the parameters and the sequence of a process of pipes welding with currents of high frequency. The welding process consists of two phases [3, 4]. In the first one the contact surface of two elements is heated using currents of high frequency. Next two welded elements are clenched.

This short description doesn't clearly present all problems that could arise during the real manufacturing process. It is also important to hold constant welding parameters. Some of these problems will be discussed below.

### 2.1. Welding parameters

To conduct the welding process in a right way one need to coordinate many important parameters. They could be reduced to the group of 7 next elements [5]:

- current frequency
- current power
- pressure force
- pressure speed
- time of heating
- welding speed
- the method of current generating

Changing one on this parameters one can obtain different runs of the manufacturing process. These parameters affect also the quality of manufactured pipes.

### 2.2. Importance of the welding process

The technology of pressure welding with currents of high frequency belongs to the group of the most productive technologies. Simultaneously it is one of the most economic manufacturing technologies.

This technology allows manufacturing pipes of different diameters and wall thicknesses. Also it is possible to manufacture pipes using different materials like: ordinary steels, alloy steels, high-alloy steels, aluminum, titanium, nickel, copper or even precious metals. One can easily prove that the range of applications, in the case of this technology, is very wide. Pressure welding could joint materials, that couldn't be jointed in other way.

Moreover, this technology allows obtaining pipes with very good mechanical parameters. It is important also, that this technology doesn't change the features of the raw material.

### 2.3. Welding technology

In the case of not complicated element this process is rather simply. But welding pipes, formed from a flat metal sheet, causes some troubles consider with the need for precision process conducting. In this case it is needed to form a metal sheet and simultaneously heat it, what is shown on the Figure 1.

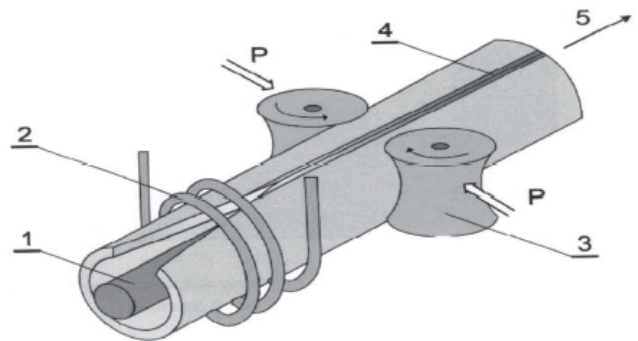


Fig. 1. Pipes welding process [6], 1 – impulse generator and ring inductor of high frequency currents, 2 – magnetic resistor, 3 – pressure rolls, 4 – weld, 5 – welding direction, P – pressing forces

This manufacturing process bases on the non-contact method of inducing currents in the edges of the metal sheet [6]. To generate these currents a special ring inductor is used. This currents heat the edges to the plasticization temperature. It is important that high frequency currents heat only a narrow zone at the edges of a metal sheet. It guarantees that the parameters of the rest of a metal sheet stay non-changed.

In the next phase the pressure rolls clench the edges of a metal sheet [7]. In a result one obtains a pipe with a pressured weld. It is important to point that this technology is a very economic one. Moreover to weld pipes in this technology one doesn't need additional materials and doesn't generate waste materials. It allows calling this technology as a cleaner one.

## 3. The pipes welding process

On the Figure 2 the scheme of the manufacturing process is presented. Particular numbers are explained below by describing the elements of the manufacturing process. The number 1 shows the identification and quality control stand of metal sheets. It is the first stage of the process. Metal sheets are stored in a form of coils. Next metal sheet coils are transported using special trolley (2). On the input stand (3) the coiled sheet is uncoiling, straightening and milling [8]. On this stand the metal sheet is also cut and joint with other metal sheets. After that the edges of the metal sheet are worked on the stand marked with number 4.

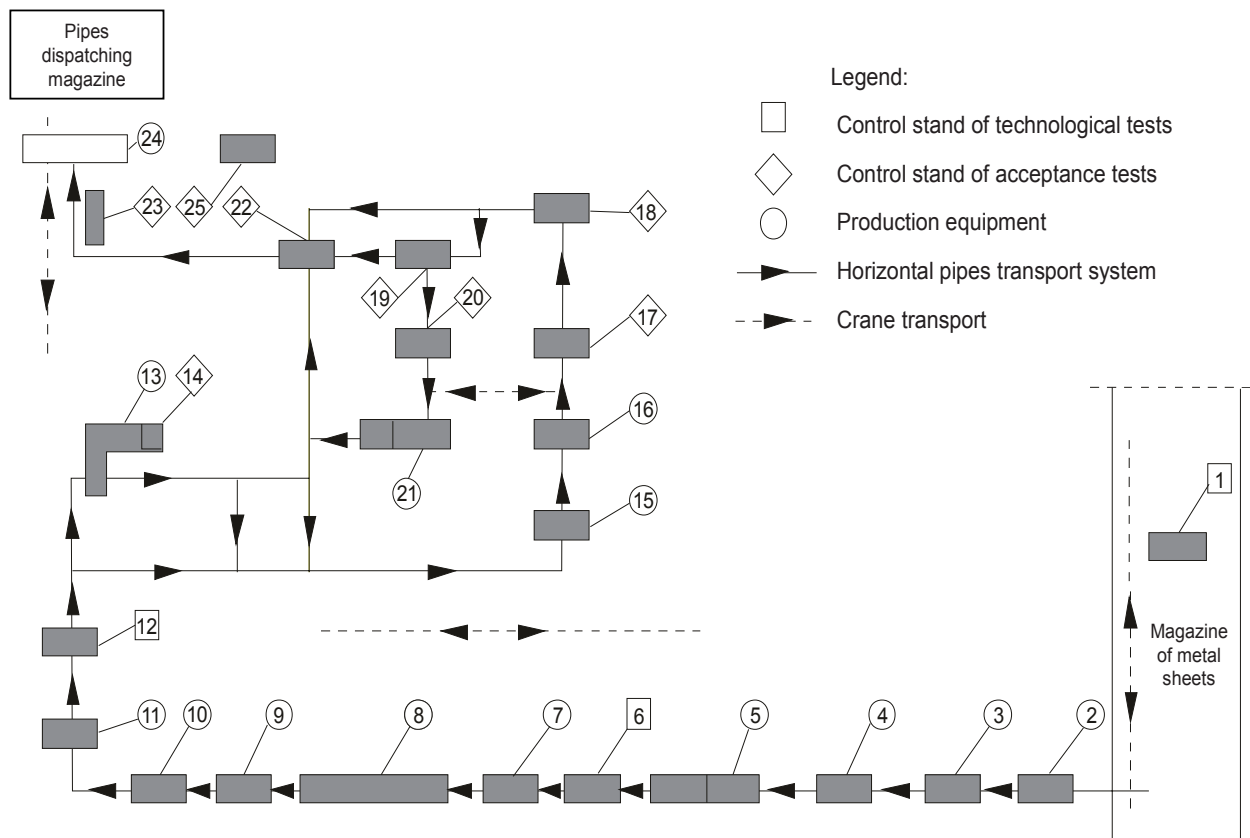


Fig.2. Scheme of the technological process

The number 5 presents the stand for pipes rolling and pressure welding. All welded pipes must be ultrasound controlled to verify all welds (stand 6) [9, 10]. Controlled pipes are exposed to a heat treatment (7). On the next stand (8) pipes are cooled using a hybrid, water-air, cooling system. This procedure results sometimes in changing dimensions of pipes, so on the stand 9 pipes are straightened and calibrated. Next pipes are cut on the saw 10. Cut pipes must be cleaned (stand 11) and provisionally controlled (stand 12). On the stand 13 the specimens for mechanical tests are sampled using special saw. The main test bases on the investigation of flattening of rings cut from the investigate pipe (14). In this point the technological process could be conducted in two different runs. The first one is for less responsible pipes. The second one includes more quality control operations.

Less responsible pipes are transported to the stand 22 for measuring (mass and length). On the stand 23 pipes are controlled and marked. The control process bases on visual inspection and magnetic investigations. Next pipes are packed in bundles (24) and transported to the pipes dispatching magazine.

The run of a process for more responsible pipes include additional quality operations between those of numbers 14 and 22 [11, 12, 13]. On the stand 15 the ends of a pipe are worked. Next the inside of a pipe is rinsed (16). Such prepared pipes are investigated on a hydraulic stand (17) to detect any leaks. All tight

pipes are visual controlled at the stand 18. The stand 19 is an automatic stand for ultrasound testing the weld and a whole pipe surface. Also manual verification ultrasound tests are conducted (20).

The pipes that were negative verified during conducted tests are repaired on the stand 21. On this stand also are cut sections that are determined as non-reparable (treated as scrap).

All pipes, which are qualified for dispatching, are described and special documents are prepared on the stand 25. In this way clients obtain all needed information. Also it is possible to find the cause of a fault when any complaint is raised.

#### 4. Welding visualisation

Welding operation is very complicated. It is consider with the fact that a straight metal band must be continuously formed to obtain the cylindrical shape. It is realized by special system of space rolling [14]. This rolling system consists of: a set of driving rolls and two sets of forming rolls. The forming rolls form so called open pipe and next a pipe with a slot.

Next Figures (3 – 6) show the particular phases of the rolling process resulting in a pipe form. These frames are parts of the simulation of the rolling process. They have been elaborated in a CAD program.

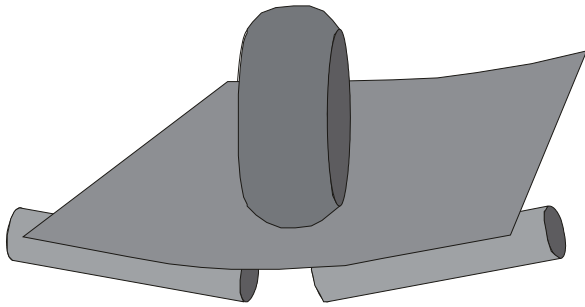


Fig. 3. Initial rolling

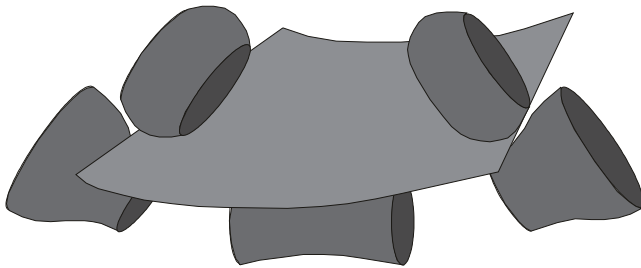


Fig. 4. Edges bending

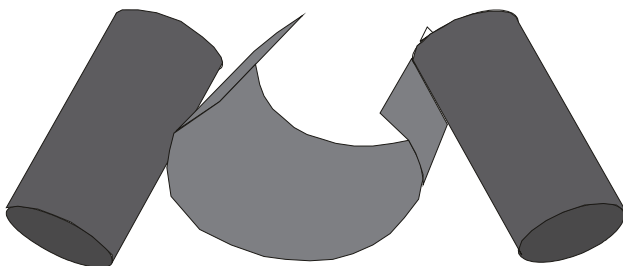


Fig. 5. Line forming – phase 2

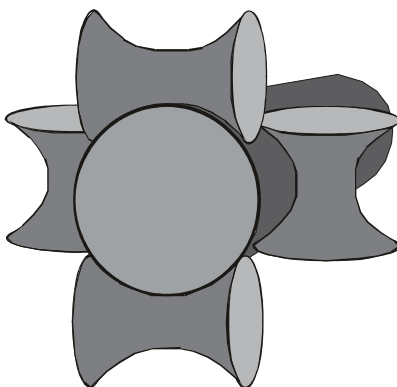


Fig. 6. Final rolling in a knife cell

## 5. Conclusions

Presented work is a result of investigations of computer aided teaching and e-learning. It exemplifies the possibility of applying modern computer tools in an educational process in the material and technology sciences [15]. This visualization is the particular result of investigations consider with other didactic tools for presenting specific technological processes.

The other task realized inside this project is to prepare an internet page being the beginning of an e-learning platform. Apart from materials presented in his paper the project of the page includes also the film presentation of the described process.

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