

# PERFORMANCE OF THE DEVICE FOR REMOVING THE INTERNAL EXCESS OF WELDING ON SEAM PIPES

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**Key words:** welding pipes, high frequency welding, internal excess welds

**Abstract:** The paper presents a design of a device for removing internal excess weld in the production of welded pipes. The pipes are welded by high frequency welding. In the pipe welding process is a very important position inductors and inner graphite core (impeder). In such circumstances, it is very difficult to install a device for removing the internal excess weld, which will ensure proper and constant removal of the weld on the pipes during the continuous production process. The presented design of the device ensures the production of welded pipes with quality removal of internal excess welds.

## 1 INTRODUCTION

Today, the accurate determination of beginning of the metallic materials plastic flow has a great importance during the metal forming with various metal forming technologies [1]. The static tensile testing, using an external extensometer to determine the proportionality limit, is used as a standard method to determine the beginning of plastic flow of metallic materials. Technologies for the production of longitudinally welded steel welded pipes have made it possible to mass-produce pipes in continuous processes significantly cheaper than seamless pipes. Today, these technologies as well as welding procedures are so advanced that it is possible to achieve the same or approximately equal quality of welds and the quality of the base material. Therefore, they have found wide application in many areas of the economy, mostly as construction pipes but also as pipes for heat exchangers, and as pipes for the transport of energy media, mainly gas, oil and water. They are produced from steel strip or sheet [1-3].

Pipes are welded by various procedures. Today, high-frequency welding is the most widely used. In this process, by passing a formed tube through a coil through which a high frequency current flows in the edges to be welded, a current is induced which heats the metal to melting. As the pipe passes through the rollers, the molten edges of the pipe are joined and welded. This causes the molten mesal to be extruded on the outer and inner sides of the welded pipe [3, 4]. This extruded mesal is called external and internal excess welds. External excess welds are always removed with specially made knives.

Removing the internal excess weld is quite complicated. However, in the manufacture of pipes used for heat exchangers, shock absorbers, etc., it is not enough to ensure an optimal excess of welds, the weld must be removed. Installing a device to remove internal excess welds is very complex in the production of small diameter pipes. It is especially complex if the pipes are welded by high-frequency process due to the inner core (impeder located below the welding point). If the device is not installed correctly, the desired quality of the pipe, especially the inner surface) will not be achieved. If heating and hot plastic deformation are carried out after welding in a continuous pipe rolling process, installing the device and ensuring proper removal of the internal weld is even more difficult.

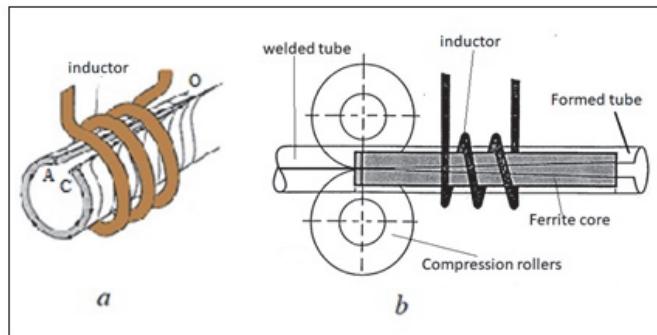
This paper presents the results of testing the possibility of removing the internal excess weld in hot - rolled of the stretch reducing of high - frequency welded steel pipes of relatively small diameter.

## 2 TECHNOLOGICAL PROCESS OF PRODUCTION OF HOT-ROLLED LONGITUDINALLY WELDED WELDED PIPES

The technological process of production of hot-rolled welded pipes consists of forming a strip in the pipe, high-frequency welding of the pipe, heating the pipe to the normalization temperature due to the uniformity of the structure in the weld and the zone of influence of heat, reheating to hot rolling temperature, hot rolling of pipes to the final dimension, cooling, finishing, testing and packaging of pipes [3, 6, 7].

The basic task of tape preparation is to ensure the required dimensions and geometry of the edges of the tape to be welded. The edges that are welded are always trimmed to remove the oxide layer, as well as dimensional deviations and various errors at the ends of the strip that occur during rolling and can affect the quality of the welded joint. After preparation, the strips are transversely welded into an infinite strip and thus ensure a continuous pipe rolling process.

The formation of the strip into a tube is carried out on a forming stand consisting of several pairs of rolls. The tape gradually bends into a tubular shape as it passes through the rollers. Poor strip formation leads to poor quality of the welded joint. The process of high - frequency welding of the pipe takes place in such a way that the high frequency current passes through the coils (inductor) and induces a current in the conductor passing through the inductor (formed unwelded pipe), Figure 1.



*Figure 1. Principle of high frequency pipe welding [4].*

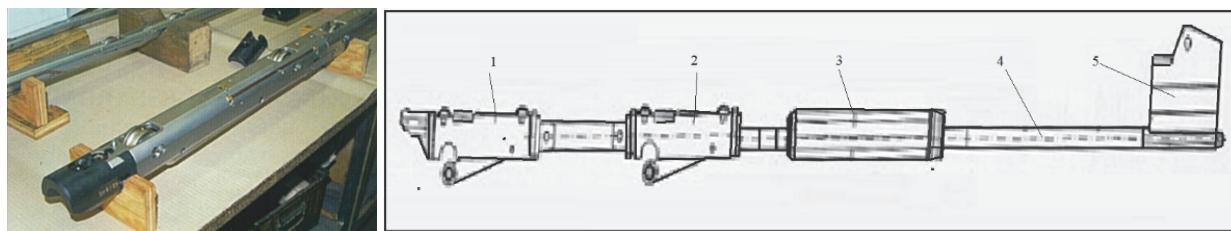
The induced current is concentrated at the edges of the strip and thus heats the AOC region, Figure 1a. At point O, the metal melts and the edges of the strip are welded by compressing rollers with a relatively small force, [3, 7, 8]. In order to reduce electricity losses, ferrite cores (impeder) are placed inside the pipe, Figure 1b. The length of the ferrite core must be such as to cover the entire length of the inductor and the welding point.

After welding, the external excess weld is removed. The pipes are heated in pass-through furnaces, first to normalization temperatures and then to warm deformation temperatures.

The stretch reducing machine consists of several in a series of installed stretch reducing rolling stands. All calibers, except the last one, are oval in shape [9, 10]. The last caliber has a round shape. When rolling pipes on stretch reducing stands, the diameter of the pipe is reduced by reducing the caliber opening, and the wall thickness of the pipe is reduced by drawing of elongation. Elongation is achieved by increasing the speed at each subsequent rolling stand, which means that rolling takes place by tensioning. After rolling, the pipes are cut to the prescribed length, tested by one of the NDT methods, and stored.

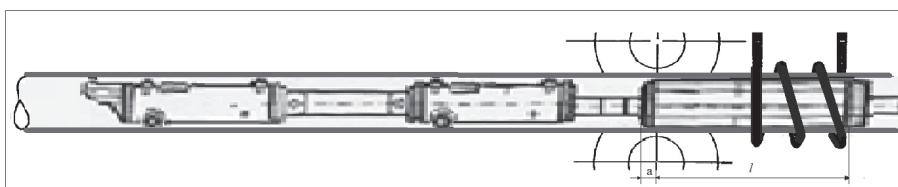
### 3 REMOVAL OF INTERNAL EXCESS WELDS

As already mentioned, before the adoption of the production of welded pipes of higher quality requirements such as boiler welded pipes, it was necessary to solve the problem of removing the internal excess weld. A device as in Figure 2 was procured from a well-known manufacturer. The proposed design of the device was supposed to ensure quality removal of internal excess weld [11].



*Figure 2. Device for removing internal weld excess*

The device for removing the internal excess welds consisted of a knife holder (1), a stabilizer (2), an impedera (3), an impeder carrier (4) and a device installation plate (5). The dimensions of the device are defined according to the diameter of the pipe and the fixed arrangement of the machines in the rolling mill of hot-rolled welded pipes. The device is introduced into the rolling stands before forming the strip into the pipe, and is fixed over the plate (5).



*Figure 3. Position of the device for removing the internal excess weld in relation to the inductor*

The impedance carrier must be of sufficient length so that the impeder covers the length from the beginning of the inductor to 3 - 4 mm behind the welding point.

The knife holder is composed of two parts in order to eliminate vibrations in operation as much as possible. On both parts there are wheels that regulate the position of the knife. They can be adjusted to ensure geometrically the best possible removal of internal excess weld, Figure 4.

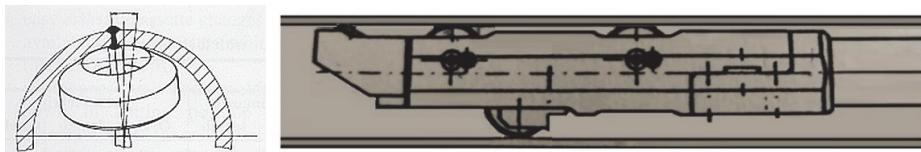


Figure 4. Device for removing the rootstock a) a knife for removing the podvara, b) a knife holder

The knife itself has a cone that depends on the inside diameter of the pipe. It must ensure that the weld is removed on both sides of the welding axis of width  $x$ , Fig. 4a, or of such a width that the pipe wall is not damaged. It can be rotated by a certain angle when worn out and in this way the longer operation of the device is ensured. It can also be sharpened as needed. Under the knife is a chopper to cut the removed excess welds. Pipes with liquid for cooling the impedance and cooling the knife pass through the supports.

Accordingly, the device has been installed and the removal of the basement has begun. Unfortunately, the device worked for a very short time and the following problems occurred:

1. after a short operation of a few minutes, the impeder burned out,
2. vibrations occurred which caused poor removal of the basement both on the outside and on the inside,
3. the scabna, similar to molten metal, is identified on the impeder, Fig. 5.



Figure 5. the scabna on the impeder

A detailed analysis showed that the impeder was oversized, so the impeder was replaced with the impeder used before the installation of the device [11]. In addition, the optimization of welding parameters was performed [13]. If the current and voltage are high and the welding speed is low, the edges of the strip will melt and the excess weld will be higher, Figure 6A). Also, the width of the welding zone will be larger. By correctly selecting the welding parameters, a pipe of good quality of the welded joint is obtained with an optimal excess of weld and the width of the welding zone Figure 6.

The figure shows the size of the internal excess weld before A and after the optimization of welding parameters B. The internal excess weld after the optimization of welding parameters is significantly smaller than the excess weld before the optimization and the same size along the length of the pipe.

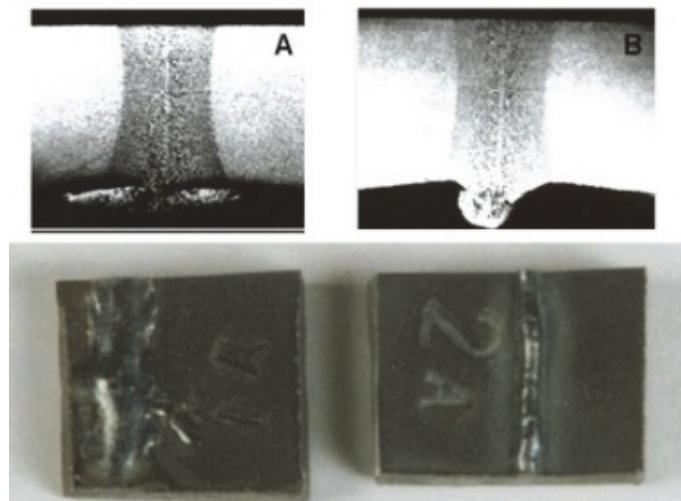


Figure 6. Weld size before and after optimization of welding parameters [12]

In this way, the burning of the impeder was partially solved. And so on, somewhat less frequently, there was an accumulation of scabna on the impeder, Fig. 5, which led to its burnout.

A detailed analysis established that the scab on the impeder does not originate from dripping molten metal of the weld zone [13-15]. Scanning electron microanalysis and X-ray diffraction methods showed that these were mainly iron oxides, Table 1. They were found to originate from the oxide layer with the surface of the strip during the formation of the strip in the tube.

*Table 1. Results of the phase analysis of the impedance scabna*

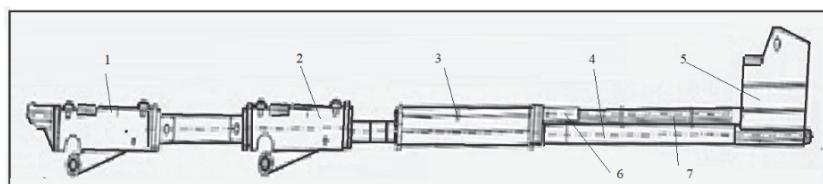
Identificirane faze	Uzorak		
	1	2	3
Fe <sub>3</sub> O <sub>4</sub>	+	+	+
α Fe <sub>2</sub> O <sub>3</sub>	+	+	+
FeO	+	+	+
FeO	+	+	+
FeS	-	+	-
2FeO SiO <sub>2</sub>	-	-	+

However, the question remains how the covarine that forms in the forming stand reaches the top of the impeder. Detailed monitoring of the operation of the device showed that the scab is due to the formation of vacuum in the pipe when, after extraction, the still warm pipe is cut with a flying saw. Therefore, a pressure air supply pipe was installed on the debugger to remove debris. At the end of the impeder is placed a "cap", Fig. 7,. In this way, the oxide layer - covarine was constantly removed and did not come into contact with the impeder.

By conducting research and changes in the design of the device, the problem of removing the fraud has been solved.

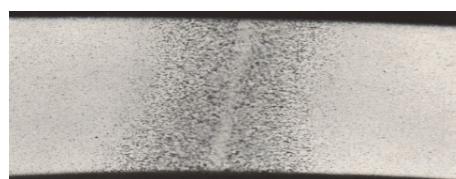


*Figure 7. a) air supply pipe on the impeder bracket, b) "cap" on one side of the impeder*



*Figure 8. Schematic representation of a new weld removal device*

In the test rolling of the pipe with the "new device", the total planned quantity of 17 t of pipe measuring ø60.3 x 3.2 mm was rolled out. There were no problems with the device during pipe rolling. Rolled pipes had better mechanical and technological properties than required by the norm. The quality of the removed podvar is visible in Figure 9.



*Figure 18. Tube with removed inner weld excess*

The figure 6 clearly shows that the pipe has a well-removed internal weld excess. Extensive technological tests of the pipes have also been carried out, which give a better picture of the weld quality of the welded pipe. The results of the tests clearly show that the pipes have good weld quality and the internal excess of welds has been properly removed. This enabled the adoption of the production of boiler welded pipes.

#### 4 CONCLUSION

The performed tests have shown that when removing the internal excess weld, it is very important to optimize the welding parameters first. The purchased device for removing the internal excess weld did not give the desired results. Modifications made to the device ensured good operation of the device. Pipes with well-removed basement were rolled out. In this way, the conditions for the production of boiler welded pipes are provided.

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