

The algorithm of verification of welding process for plastic pipes

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Abstract. The study analyzes the process of butt welding of PE pipes in terms of proper selection of connector parameters. The process was oriented to the elements performed as a series of types of pipes. Polymeric materials commonly referred to as polymers or plastics, synthetic materials are produced from oil products in the polyreaction compounds of low molecular weight, called monomers. During the polyreactions monomers combine to build a macromolecule material monomer named with the prefix poly polypropylene, polyethylene or polyurethane, creating particles in solid state on the order of 0,2 to 0,4 mm. Finished products from polymers of virtually any shape and size are obtained by compression molding, injection molding, extrusion, laminating, centrifugal casting, etc. Weld can only be a thermoplastic that softens at an elevated temperature, and thus can be connected via a clamp. Depending on the source and method of supplying heat include the following welding processes: welding contact, radiant welding, friction welding, dielectric welding, ultrasonic welding. The analysis will be welding contact. In connection with the development of new generation of polyethylene, and the production of pipes with increasing dimensions (diameter, wall thickness) is important to select the correct process.

1. Introduction

The paper presents algorithm of verifying the welding process, the type series of PE pipes. The presented algorithm of allows to verify the process and provides a database of information about the correctness of the connection. The application suggests that proper maintenance operations in order to obtain correct seal. The process is shown in a block. Also performed simulations of this process using the welding machines of pipes in diameters from $\varnothing 110$ to $\varnothing 225$.

The butt weld process and the entire preparatory procedure are determined by the German DVS 2207 standard. In fact, many companies carry out their own research to streamline the process and adjust the parameters to their own products.

2. Characteristics of the welding process

The process of selection of welding parameters is performed for PE plastics, [2]. Polymer materials, commonly called plastics or polymers, are synthetic materials produced from petroleum products by the process of low molecular weight molecular weight polymerization, called monomers [2, 5].



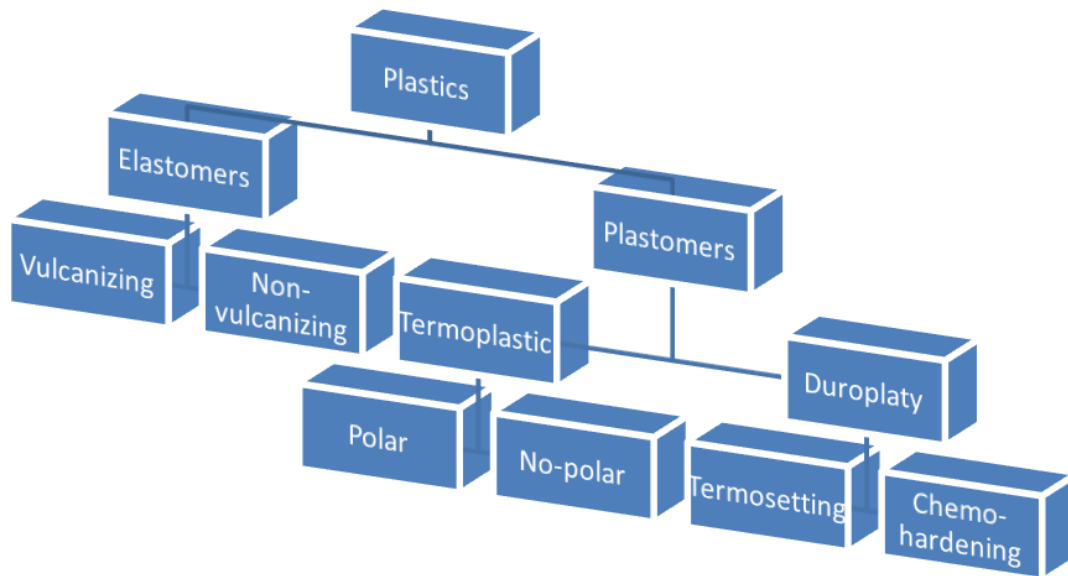


Figure 1. Division of Plastic [3].

Only thermoplastics can be welded. Thermoplastics soften at elevated temperatures and thus can be joined by pressure.

Depending on the source and the method of heat supply, the following welding methods are distinguished: contact welding, radiant welding, friction welding, dielectric welding, ultrasonic welding. The basis of analysis will be contact welding, [4,5]. The process of welding the external heating element runs in stages:

- Heating the contact area of the welded items to the specified welding temperature (STAGE I and II),
- Ejecting the heating element from the welding area (STAGE III),
- Clenching and tightening of the welding area of the joints, and Link cooling (STAGE IV and V).

The machine used to make welded joints is butt weld or welding machine. An example of a welder is shown in Figure 2 [3]. The model was made in Solid Edge.

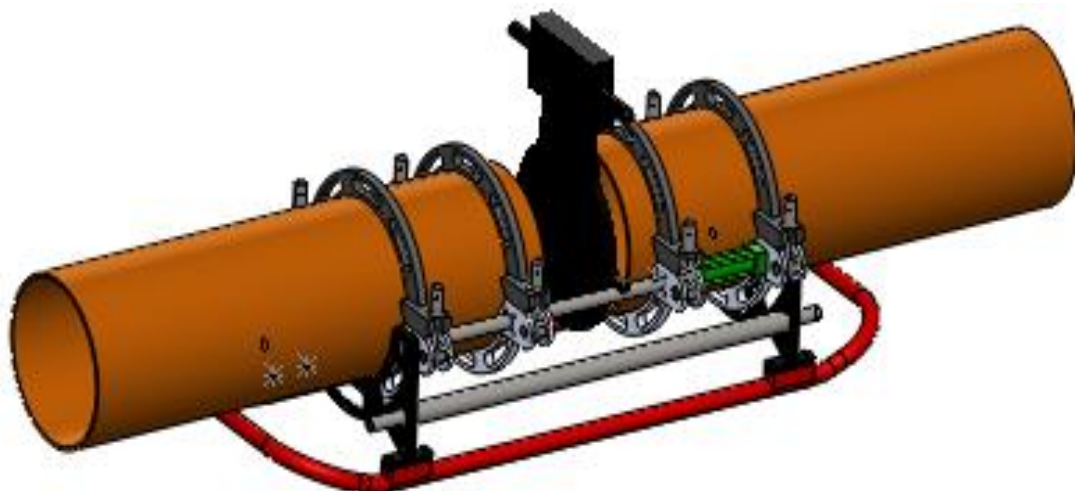


Figure 2. Model of welding machines.

3. Application schema

The algorithm created is based on the heat-sealing instructions in the standard test card. The algorithm is presented in a block way. The following describes and explains its individual blocks.

BLOCK I

It covers activities related to the preparation of welded elements and sealing machine for the welding process.

BLOCK II

It covers the whole welding process. Include:

- Download parameters forced by welded elements,
- Register of parameters obtained during welding,
- Control of individual steps and generation of error messages during the process.

BLOCK III

This is the stage of the assessment of the correctness of the weld

BLOCK SETTING AND CONTROL (BNK)

It includes clocks that set the duration of each stage,

BLOCK REGISTER (BR)

Including a register of parameters obtained during the process and critical errors.

Due to its size, only part of blocks is shown, Fig. 3, Fig. 4.

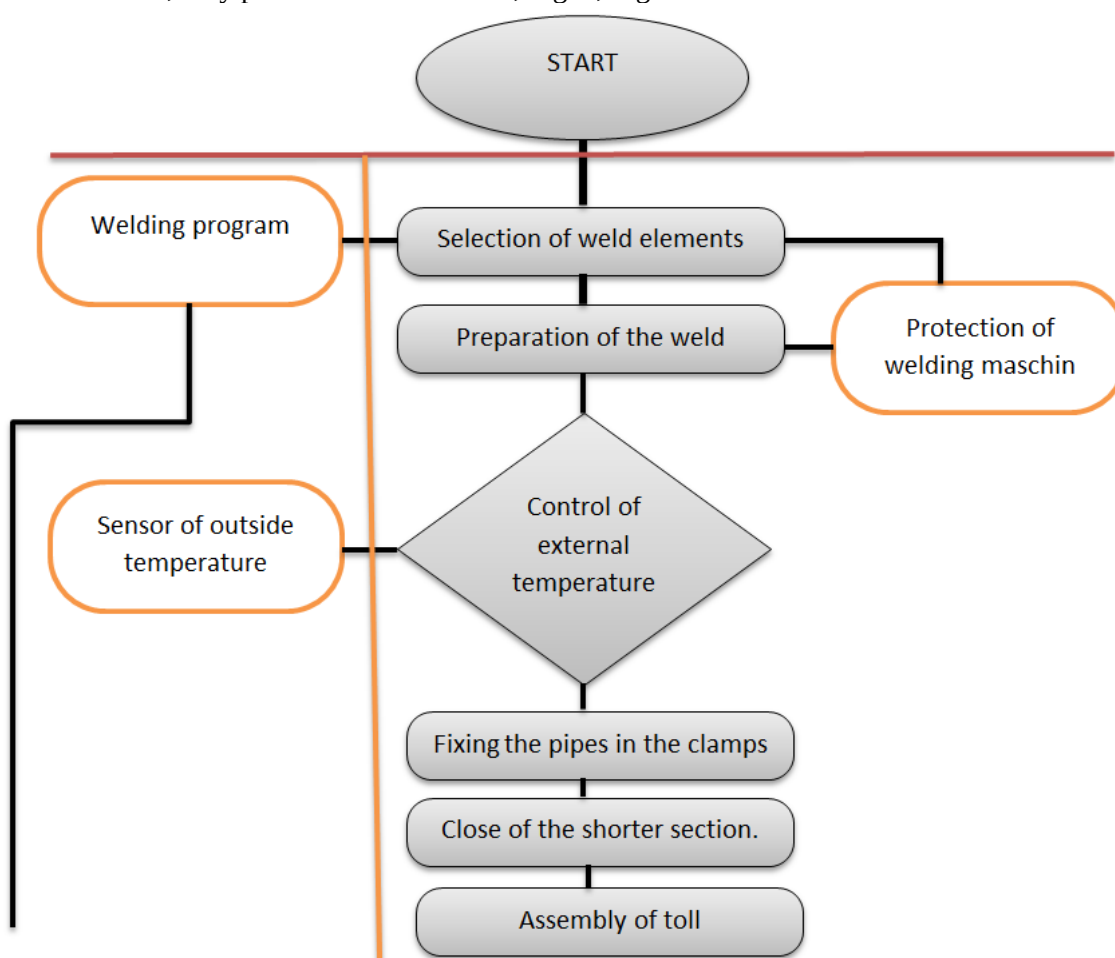


Figure 3. Block diagram of the beginning of the application.

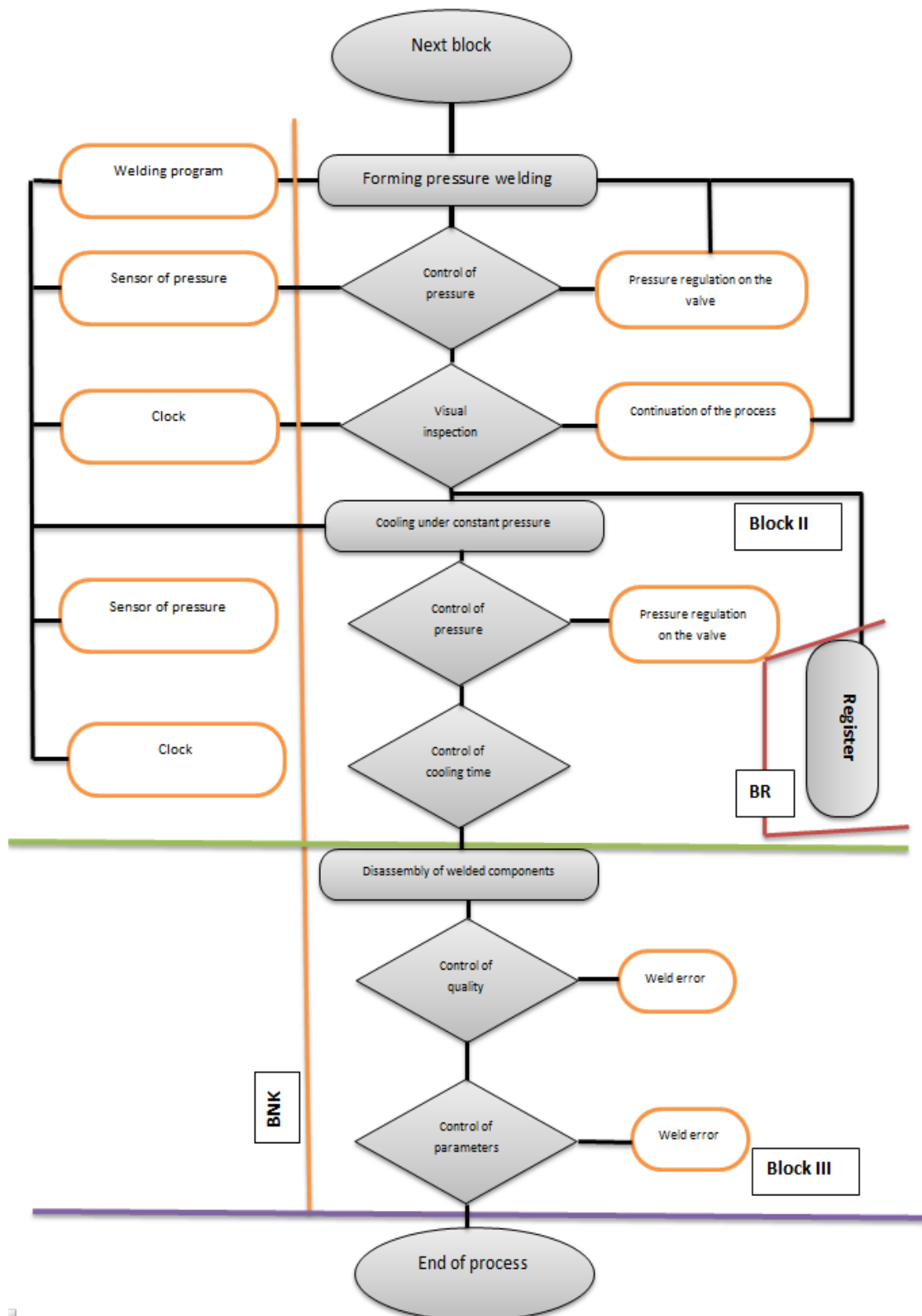


Figure 4. The final stages of welding and weld control.

4. Welding process simulation

The software simulation of the welding process was carried out exclusively on the computer. The program is based on a series of commands connected serially, [1]. A number of operations on the welding machine are performed one by one, without the possibility of returning to the former. The program consists of 24 instructions that are linked and interdependent in a serial way. Only the correct execution of the entire instruction allows you to move on to the next. If the conditions are not met, the program generates an error message or a procedure to correct the error. Example dialogs are shown in Figures 5, 6, 7.

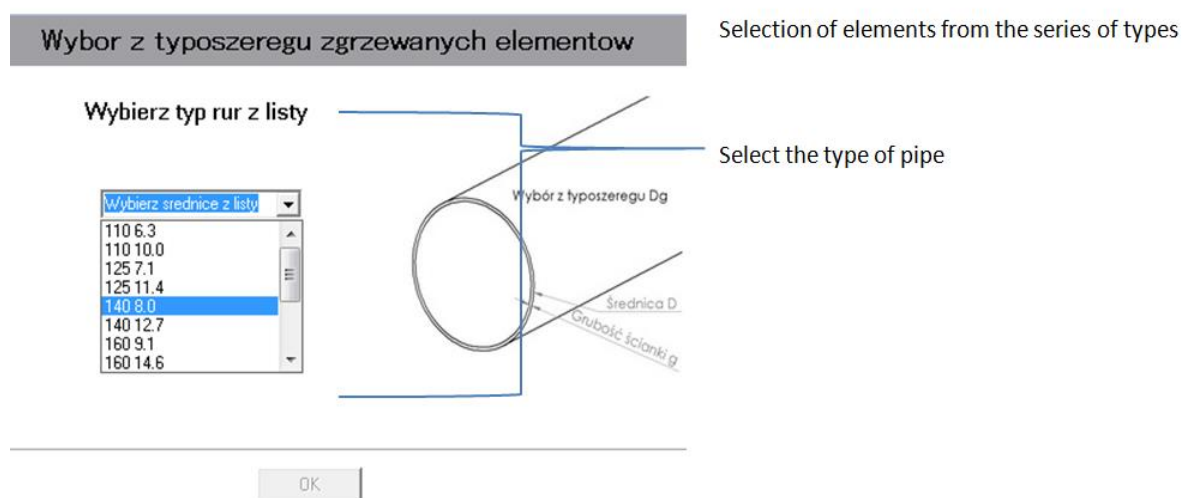


Figure 5. Selection of the type welded elements from the series of types.

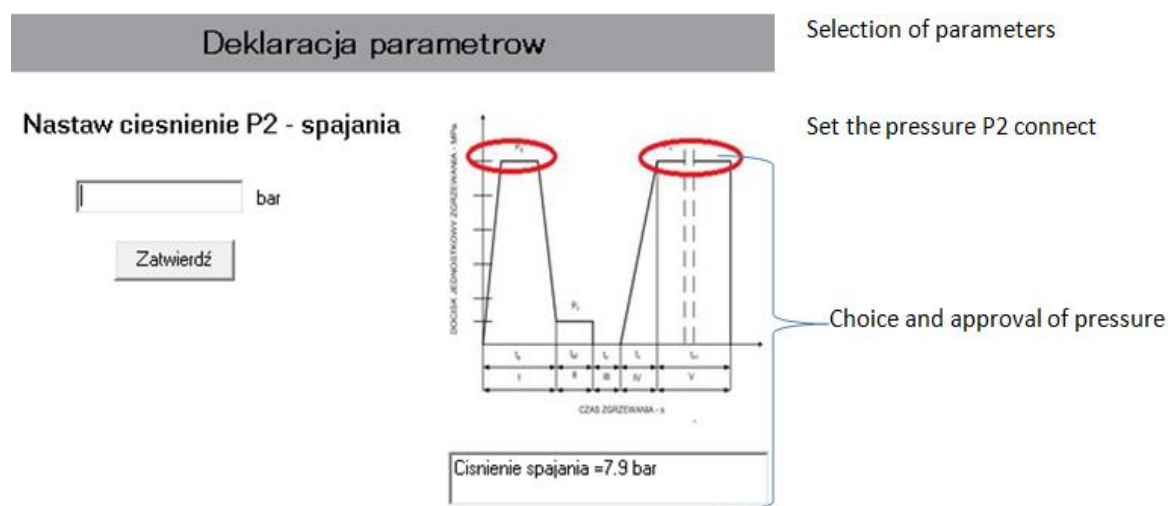


Figure 6. The dialog box set pressure for the process.

I i II Etap zgrzewania

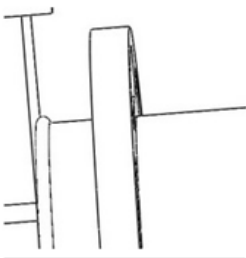
Etap I zgrzewania

☒ Narost ciśnienia do wartości P2

Etap II zgrzewania

Wysokość wstępnego uformowania wypływu

☒ TAK ☐ NIE



Wymagana wysokość = 0.5 mm

I and II welding step

Stage I

Pressure build-up to the value p2

Stage I

Height of initial molding

YES or NO

Value required

Zastawienie parametrów

Średnica D=	125	[mm]	Wykaz Zakończ
Grubość ścianki=	7.1	[mm]	
Ciepłota nagrzewania max.=	4.3	[bar]	
Czas nagrzewania=	120	[s]	
Czas przestawienia=	6	[s]	
Czas spajania pod ciśnieniem=	7	[bar]	
Czas chłodzenia pod ciśnieniem=	10	[bar]	
Ciepłota max.=	7.9	[bar]	
Temperatura płyty=	220	[C]	

Parametry zadane

Średnica D=	125	[mm]
Grubość ścianki=	7.1	[mm]
Ciepłota nagrzewania=	4.0	[bar]

List of parameters

Dimeter D

Thickness of the wall

Pressure heating max.

Time of pressure

Operating time

Time of joining under pressure

Time of cooling under pressure

Max pressure

Plate temperature

Selected parameters

Dimeter D

Thickness of the wall

Pressure heating

Figure 7. Panel welding compilation of results.

5. Conclusions

The program is designed to select the parameters of the weld, for the welders with the heating plate. It is made in the form of an application for training purposes. In an intuitive way the operator performs the welding process. Provides all information about operator operations. No reference to external sensors and connections to the control system will result in the performance of the sensor being always close to the ideal.

6. References

- [1] Gendarz P 2002 *Methodology for ordered sets of machine constructions creating* Silesian University of Technology, Gliwice, Poland
- [2] Bąkowski K. 2007 Gas networks and installations (Warsaw: WNT Publishing House)
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- [4] Rzański R 2015 Technological similarity theory model for series of types of constructions, *Special issue: Evolution of modern manufacturing processes, technologies and materials, Int. J. Materials and Product Technology* **50** (3/4) p. 289 – 305
- [5] Klimpel A 1999 Welding technologies for metals and thermoplastics, Silesian University of Technology, Gliwice, Poland