MODULAR DEVICE FOR THE TESTING OF NON-DISMOUNTABLE ASSEMBLIES OF PEHD PIPES

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Abstract: this paper presents the design of a modular gripping device for the testing of PEHD pipes non-dismountable electro-fusion and butt-welding assemblies. The integrity of the pipes welding is very important, because these pipes are used for the transportation of pressurized liquids and gases. The device is conceived in such a manner that allows the testing of circular pipes of various diameters welded by electro-fusion, as well as rectangular-shaped samples taken from the walls of butt-welded pipes. This device will be used on the hydraulic press from the Mechanics Laboratory of the Faculty of Management and Technological Engineering (University of Oradea) in order to diversify its possibilities of use.

1. INTRODUCTION

The polyethylene pipes systems play a more and more important role in the water and gas supply networks and in industrial applications. The superior material characteristics, the easy handling and installation and the excellent price/quality ratio is advantageous for this system, mainly in pressure applications. Among the multiple advantages of the polyethylene pipes there are:

- no corrosion;
- water drinkability;
- resistance to low temperatures;
- high resistance to mechanical shocks;
- flexibility;
- high chemical resistance;
- the assemblies by butt-welding and electro-fusion ensures a homogeneous mechanical resistant pipe system;
- small mass;
- prolonged life duration;
- easy installation.

The multiple applications of polyethylene piping derive from the mechanical, thermal and chemical of the material, which are synonyms to: practical, durable, reliable. The use range of the polyethylene pipes are:

- drinkable water distribution systems;
- irrigation networks;
- fire-fighting networks;
- liquid food transportation lines;
- industrial liquid transportation lines;
- gas distribution networks;
- urban sewerage networks;
- water treatment installations;
- drainage systems;
- special environment drainage systems;
- sewerage in the interior of civil constructions;
- protection systems for electrical cables;
- protection systems for telephone networks;

- special ventilation pipes;
- pipes for abrasive liquids.

The attained results so far confirm the validity of polymer use in pressure piping. The polymer used for pipes features a molecular structure that guarantees the maintaining of the mechanical characteristics for at least 400000-500000 hours of operation, at nominal pressure and 20°C fluid temperature. The superior material characteristics, the easy handling and installation and the price versus quality ratio are major advantages of this system. Due to flexibility and low mass, the polyethylene products are easy to transport and allow the installation of long pipes in relative short times. Papers [1, 2] present some types of non-dismounting assemblies of PEHD pipes, their defaults and the ways to check their quality.

2. DESCRIPTION OF DEVICE AND ITS OPERATION

Fig.1 presents the assembly drawing of the gripping device used for testing of circular section pipes assembled by electro-fusion, and fig.2 shows the device for gripping and testing rectangle-shaped sections taken from butt-welded pipes. In facts, both figures are showing the same device, with different interchangeable modular gripping elements. Fig.3 shows the components of the gripping device, with interchangeable modular elements 5 (for circular samples) and 7 (for rectangular samples).

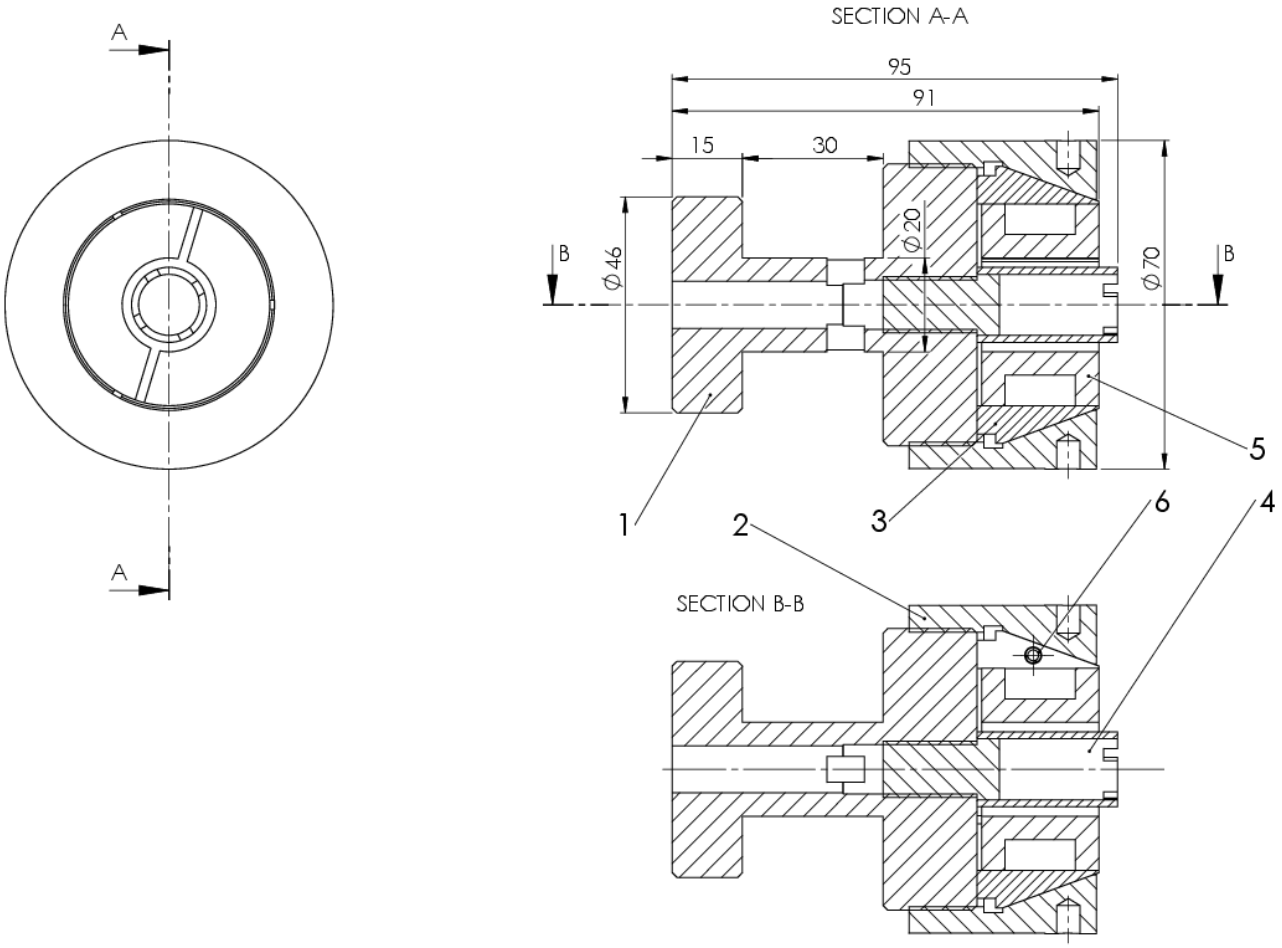


Fig. 1. Device for gripping and testing of pipes welded by electro-fusion; 1 – body, 2 – nut, 3 – jaw, 4 – spigot, 5 – gripping element, 6 – spring.

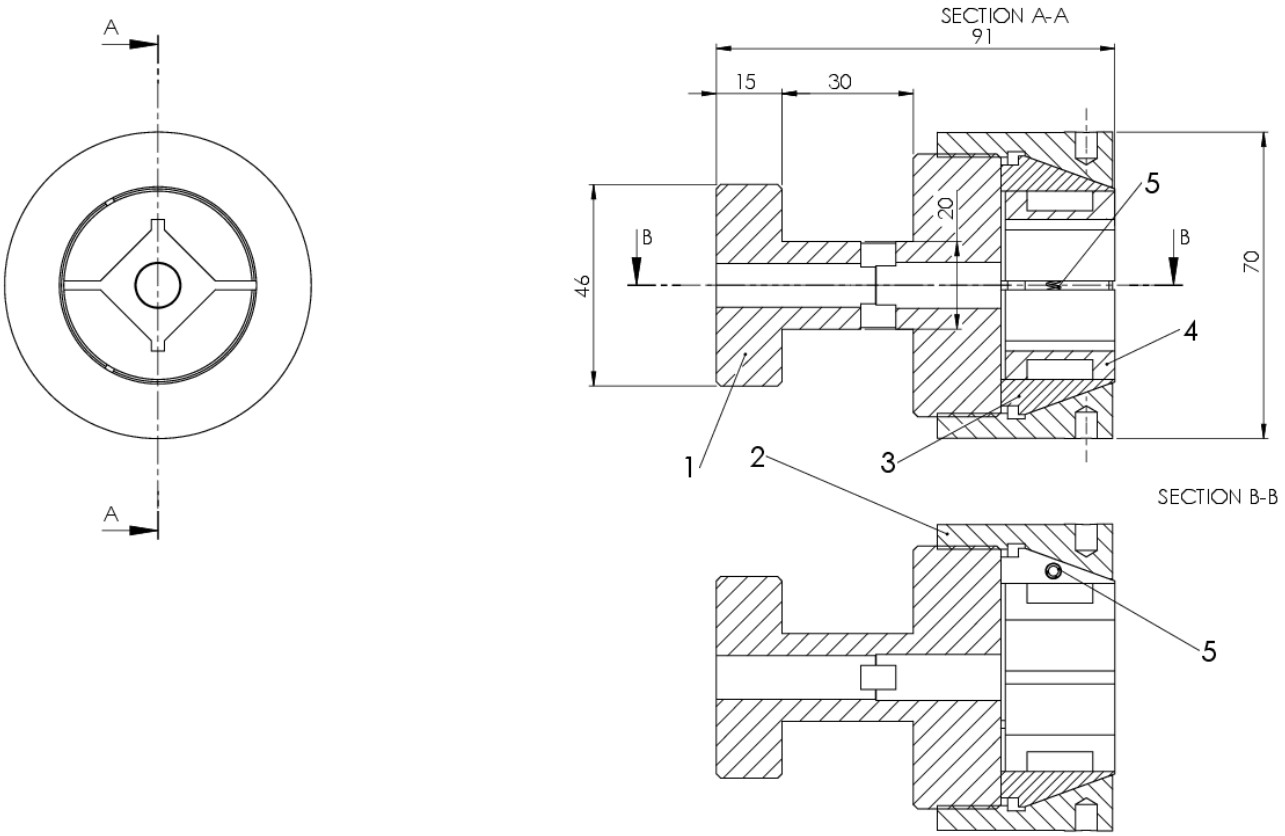


Fig. 2. Device for gripping and testing of samples taken from butt-welded pipes; 1 – body, 2 – nut, 3 – jaw, 4 – middle bushing, 5 – spring.

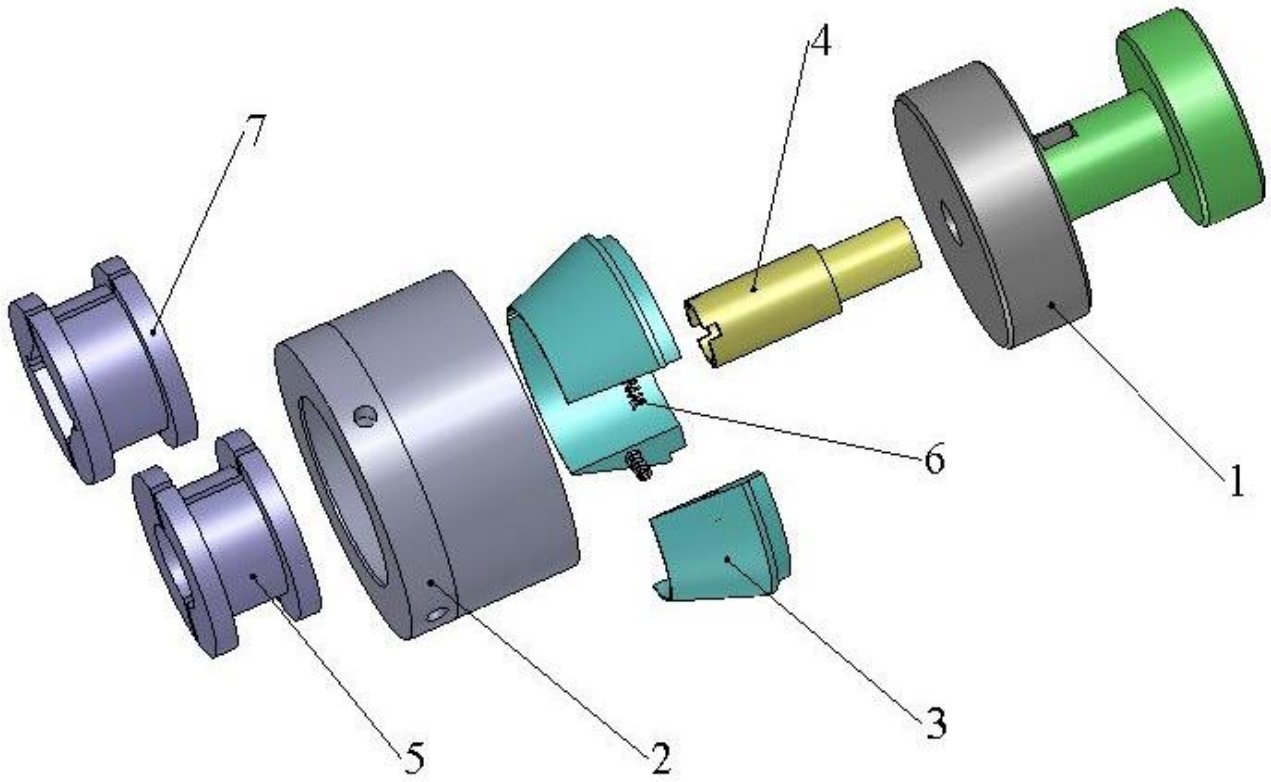


Fig. 3. Components of the gripping device; 1 – body, 2 – gripping nut, 3 – jaw, 4 – spigot, 5 – modular element for gripping of circular pipe samples, 6 – spring, 7 – modular element for gripping of rectangular pipe samples.

In order to test pipes assembled by electro-fusion or samples taken from butt-welded pipes, two of these devices are necessary, which are mounted into the work heads of the hydraulic press used for testing. Fig.4 shows the grip of a circular pipe welded by electro-fusion, and fig.5 shows the grip of a rectangular-shaped sample taken from a butt-welded pipe.

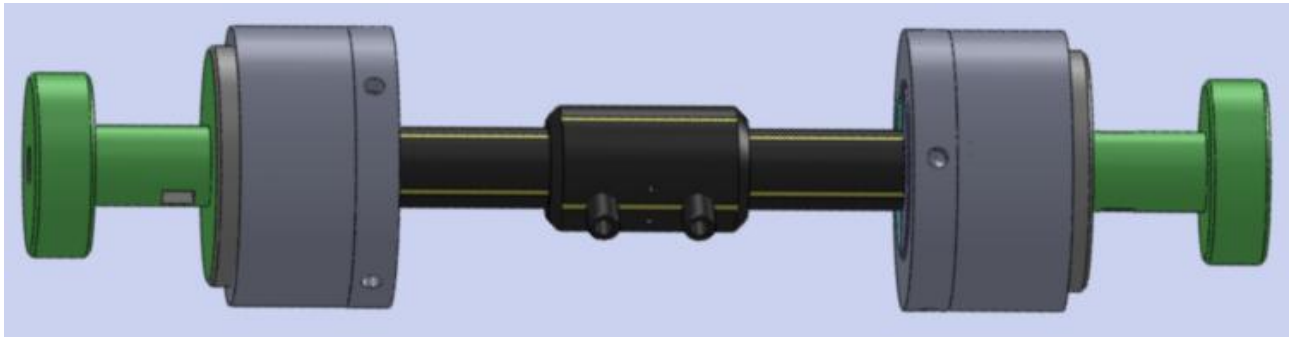


Fig. 4. Grip of a pipe welded by electro-fusion, for testing.

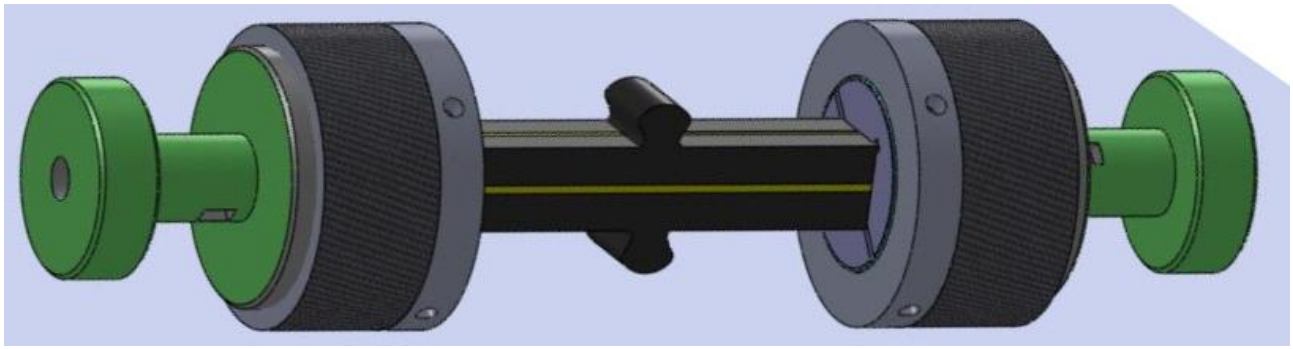


Fig. 5. Grip of a rectangular-shaped sample taken from a butt-welded pipe, for testing.

According to the diameter of the pipe to be welded by electro-fusion, adequate standardized fitting pieces are chosen, which are produced by several specialized manufacturers, such as *Fusion* (Great Britain), *Wavin* (Holland), *Georg Fischer*, *Friatec*, *Plasson* (Germany), *Uponor* (Finland) etc. These are produced by injection in special moulds [3, 4].

During testing for more and more intense traction efforts, the weld must not give, that is the two pipe halves must not come loose from the electro-fusion welding element, and the weld must not tear apart. Fig.6 show a correctly made electro-fusion weld, where the fitting stayed intact and the left half of the pipe is deformed, and fig.7 shows a correctly made butt-welding, with the weld intact and the left half of the sample deformed.

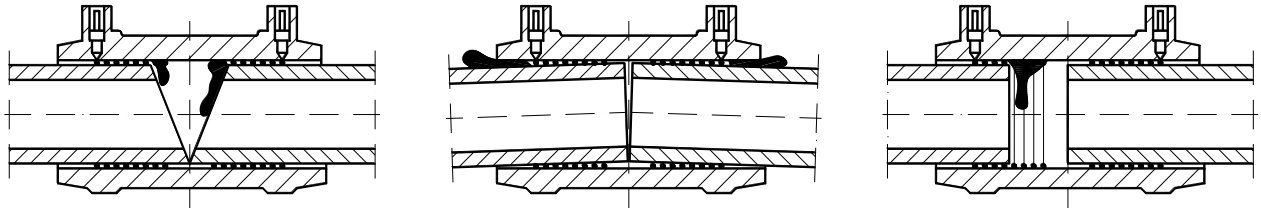
Fig. 6. Correct electro-fusion weld.

Fig. 7. Correct butt-welding.

3. WELD DEFAULTS AND CONTROL

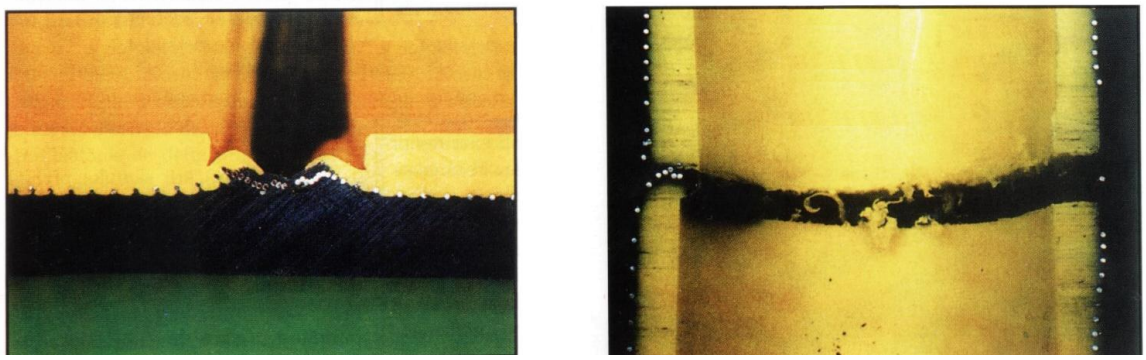
The most common electro-fusion weld defaults [1, 5] are caused by:

- lack of parallelism of the pipes ends (fig.8.a);
- lack of visual and dimensional control for the pipes and the weldinf constructive elements;
- lack of cutting away the deformed pipes ends;
- lack of adequate equalization of the pipes and constructive components;
- non-adequate cleaning of the pipes;
- insufficient or excessive working of the pipes;
- lack of penetration depth marking, thus a faulty binding (fig.9.a and fig.8.c);
- insufficient holding of the pipes (fig.8.b);
- lack of checking the groove for sharp impurities (pieces of rock, glass etc);
- insufficient protection at interruptions;
- wrong welding parameters (fig.9.b), caused by using wrong magnetic cards for the constructive components.



a ***b*** ***c***

Fig. 8. Defaults at electro-fusion welding: a – non-parallel pipes ends; b – angled pipes; c – partial penetration of pipes in the fitting.



a ***b***

Fig. 9. Defaults at electro-fusion welding: a – insufficient penetration depth; b – wrong welding.

In the case of butt-welding, the following rules must be observed: the bottom of the weld burr must be above the pipes surfaces, the misalignment between the pipes outer surfaces must not exceed 5% of the pipe wall thickness, the width of the weld burr must be constant for the same pipe type (same inner and outer diameters, same wall thickness), and in the case of non-symmetrical burrs (fig.10) the difference between the larger and smaller burrs Δs must be calculated and must comply to the following conditions: $\Delta s \leq 0{,}1 \cdot B$ when welding pipe to pipe, respectively $\Delta s \leq 0{,}2 \cdot B$ when welding pipe to fitting or fitting to fitting. Also there must not be any deterioration caused by the gripping devices in the area where the pipe was fixed. When the burr is cut, it should be observed that its width must be constant and there are not any problems inside the weld, such as impurities, voids, misalignments and other faults, of which the most dangerous are fissures and incomplete melting.

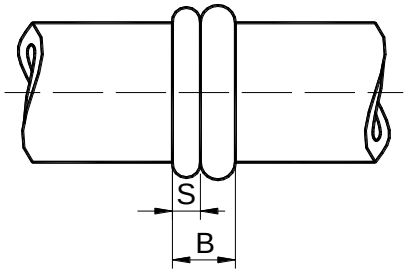


Fig. 10. Non-symmetrical burrs.

Along with the traction tests, in order to check the quality of welds there are also other tests to be carried out, such as:

- ✓ **Visual control:**

The weld indicators must be on the outside. Deformations of pipes and/or fittings in the weld area are not admitted.

- ✓ **Breaking at internal pressure:**

The taken samples have lengths according to the nominal pipe diameter, such as: 300 mm for d ≤ 63 mm, and 600 mm for 63 mm ≤ d ≤ 225 mm. The test is carried out for 170 hours, at 80°C temperature, at $0.6P_N$ pressure for type 1 pipes and at $0.8P_N$ pressure for type 2 pipes, where P_N is the nominal pressure for the pipe under test. The pipe must withstand this test without breaking.

4. CONCLUSIONS

In order to attain non-dismountable assemblies of pipes by means of heated element butt-welding or electro-fusion, it is very important to respect the welding temperatures and times. These parameters are set by the producers of the welding devices, according to the wall thickness of the pipes to be welded and to the nominal pressure they are to be operated at. The optimal welding parameters can be found in printed catalogs, in electronic libraries and memorized on magnetic cards that come attached to the welding devices and/or to the pipes themselves.

The originality of this device consists of the fact that it can be fitted on hydraulic presses that were not initially designed to test thermoplastic materials, but only metal. By adequately changing the modular gripping elements, plastic pipes of several dimensions and assembled by butt-welding or electro-fusion can be tested. The device can be certified and can be included in the equipment of the hydraulic presses of the material testing laboratories.

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