

# Qualitative and Quantitative Comparisons Concerning the Influence of Jointing Parameters on the Quality of the PPR Without Insertion Components Assembly

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*This paper presents the results of the research carried out in order to establish the optimum technology of polypropylene pipes, analysed from the point of view of temperature, time and labour press. Analysing the values obtained in the practical samples, the graphics of variation of components after assembly were traced, decreasing the diameter of the pipe after the assembly, the parameters that define significantly the quality of the assembly. The need to address such themes derived from the fact that in the literature, in the present time there are not sufficient and relevant information with regard to the assembly of pipes and connectors of PPR, most of the information being provided by the manufacturers and they are confined to the indication of the parameters of the assembly process.*

*Keywords: assembly, polypropylene, ridge, temperature, shrink*

It is well known that until about 15 years ago, the sanitary installations/warm or cold water were made of materials such as galvanized steel or more serious lead alloys.

Modern solutions for replacing the existing pipes are represented by the use of polypropylene pipes (PPR), copper, and polyvinyl chloride (PVC) or galvanized steel. The adoption of such solutions are based on the fact that their life is much higher compared to the existing ones, for example, for polypropylene pipes is around 55 years of age, and for those of copper approximately 50 years [1].

As the main areas of the applicability of the PPR pipes, we can enumerate : sanitary installations, reservoirs, distribution network, radiators filling, pipes networks, etc. [1] but can also be used in the implementation of green buildings [2].

A comparison between the various types of materials used in making installations is indicated in table 1 [3].

It is considered that currently replacing older pipes older than 20 years must be made even if they have not yet given away, based on the fact that there are deposits on the walls of pipes that led to the significant reduction of inner diameter. Another cause which may influence the decision of replacement is the date of the occurrence of

corrosion which can lead to reducing the wall thickness of the pipes and the cession of their time in operation.

## Experimental part

### Materials and equipment

Polypropylene is a plastic material, more resistant to heat than polyvinyl chloride (PVC), which is the application in plastics industry, especially in installations of heating [4].

The pipe used in the experiments was of type Kaldi PPR PIPE SDR6/S2.5. PN 20 Ø20 x 3.4 mm manufactured in accordance with DIN 8077/78 and the socket is of type PPR12 PN 25 Ø20 TIPO 3. In table 2 are shown the working pressures for water and sanitation systems and in table 3 it is presented the working pressure for heating systems made of pipes SDR type 6/S 2.5 PN 20 [5].

### Assembly technology Parameters

Generally, the parameters of the assembly technology of pipes from RPP are represented by the temperature at which thermostatically controlled hotplate, the time for the corresponding temperature and the press force from the moment of bringing in contact those 2 components.

No	Parameter	Galvanized steel	Metal	PVC	PPR
1.	Life duration [years]	5-15	10-30	10	> 50
2.	Assembly method	Merge with thread	Welding	Other materials	Melting
3.	Time for completion of the merge	Hours	Hours	Minutes	Seconds
4.	The connection resistance	Good	Good	Good	Excellent
5.	Features of embrittlement	Resistant	Resistant	Weak	Very Resistant
6.	Resistance to corrosion	Very poor	Weak	Weak	Very good
7.	The ease of realization of assembling	Difficult	Difficult	Relatively difficult	Easy
8.	The ease of repairing and maintenance	Difficult	Difficult	Difficult	Easy
9.	Ecological	Not	Not	Not	Yes

**Table 1**  
COMPARISON OF  
VARIOUS PIPE SYSTEMS  
[3]

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No.	Temperature	Years of service	Limit of the working pressure (bar)
1	20 ° C	5	44.29
		10	42.65
		25	41.06
		50	39.35
2	75 ° C	5	16.85
		10	14.51
		25	11.59

**Table 2**  
WORKING PRESSURE FOR  
SANITARY WATER SYSTEMS MADE  
OF PIPES SDR 6 TYPE/S 2.5 PN 20  
(EXCERPT FROM [5])

No.	Temperature / working time at ....	Temperature	Years of service	Limit of the working pressure (bar)
1	Constant temperature 70 ° C and more 30 days/year .	80 ° C	5	17.56
			10	16.48
			25	14.21
			42.5	12.36
2	Constant temperature 70 ° C and more 90 days/year .	80 ° C	5	16.78
			10	15.9
			25	12.81
			37.5	11.41

**Table 3**  
WORKING PRESSURE FOR  
HEATING SYSTEMS MADE OF  
PIPES SDR TYPE 6/S 2.5 PN 20  
(EXCERPT FROM [5])

The stages necessary for the assembly are [6, 7] :

- mounting both ends of the clamping dies, fixing it with screw clamping;
- the device shall be supplied and shall let that heated elements to reach the manufacturers recommended temperature of pipes and fittings in the RPP;
- it is made the contact with heated elements components of PPR and the duration of the heating pipes or PPR fittings to be given by the manufacturer thereof;
- the components are put in contact and they are pressed with a certain force;

In order to establish the optimum assembly technology, in the experiments, we have been using the parameters indicated in the table 4. Also, in this table are indicated the lengths of pipes and connectors used in the assembly.

#### Results and discussions

Following the completion of the collations resulted samples shown in figure 1. After obtaining these samples, they were measured with electronic callipers to determine the dependence of the parameters of the assembly process and the shortening of samples. Shortening is defined as

Sample coding	Temperature [°C]	Maintenance time [s]	The contact press force [N]	Socket length [mm]	Pipe length [mm]
1.1	200	8	20	37	98.9
1.2	200	8	30	37	100.12
1.3	200	8	50	37	100.96
1.4	200	10	20	37	99.96
1.5	200	10	30	37	101.3
1.6	200	10	50	37	99.35
1.7	200	12	20	37	99.78
1.8	200	12	30	37	99.26
1.9	200	12	50	37	100.13
1.10	250	8	20	37	100.6
1.11	250	8	30	37	98.59
1.12	250	8	50	37	100.43
1.13	250	10	20	37	101.53
1.14	250	10	30	37	99.37
1.15	250	10	50	37	100.5
1.16	250	12	20	37	99.68
1.17	250	12	30	37	102.2
1.18	250	12	50	37	99.44
1.19	300	8	20	37	101.32
1.20	300	8	30	37	101.11
1.21	300	8	50	37	100.26
1.22	300	10	20	37	99.91
1.23	300	10	30	37	99.66
1.24	300	10	50	37	100.82
1.25	300	12	20	37	98.95
1.26	300	12	30	37	101.8
1.27	300	12	50	37	101.28

**Table 4**  
ASSEMBLY PROCESS PARAMETERS,  
PIPES LENGTHS AND CONNECTORS

the difference between the length of the components before the assembly and the length of the components after assembly (fig. 2).

On the basis of the values obtained, the shortening variation is indicated in figure 3.

From the analysis of the graph above it can be seen that through the variation of the parameters of the process of assembling (the temperature of 200, 250 and 300 degrees Celsius, temperature time-maintaining at 8, 10, 12 seconds



Fig.1. Obtained samples

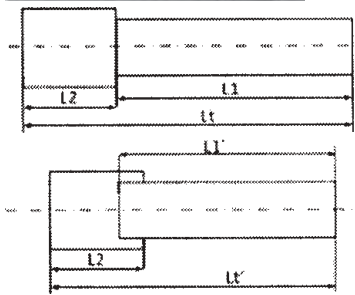


Fig. 2. Shortening the assembled samples  
L1 - pipe length before the merge, L2 - connector length before and after the merge; L1' - pipe length after the merge ( $L1' < L1$ ), Lt - overall length components before assembly, Lt' - length assembly

and the contact press force 20, 30 and 50 N) does not follow a linear change of shrink. As expected the highest value of shrink, 15.79 mm is obtained when using the maximum values of the parameters of the assembly process (350 degrees C, 50 N and 12s).

In the process of assembling, some of the material is expelled outwards giving rise to an external ridge and another part is directed to the inside. The amount of material from inside, results in the inner diameter reduction, so implicitly, of the default section that the liquid will pass through.

In the figure 4 are listed a few samples with examples of the ridge and the reduction of the interior section.

From the analysis in figure 5, we can see that in the case of 1.1. there is no reduction in the interior of the pipe

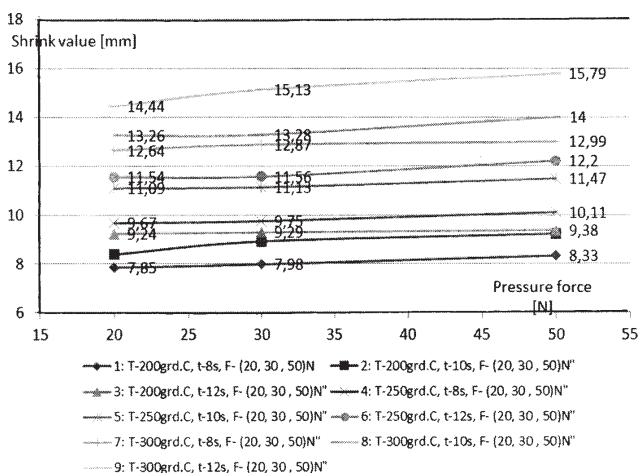


Fig. 3. The variation of shrink value

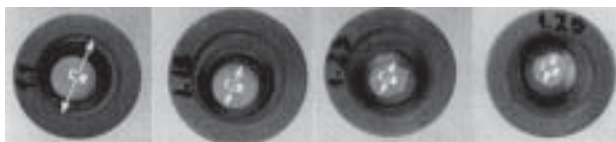


Fig. 4. Reducing the liquid passing in the event of different samples (1.1, 1.13, 1.23 and 1.25)



Fig. 5. Typical sizes determined from the measurement; 1 - pipe, 2 - interior ridge, 3 - left-right connector separation, 4 - ridge connector resulted after heating, DE - the exterior diameter of the pipe after assembly, DEA - the exterior diameter after assembling, s - connector thickness,  $s_1$  - exterior ridge thickness

section and if the sample 1.25 the reduction value of the section is the largest.

The quality of workmanship can be analysed from the point of view of the amount of the resulting ridge from the assembly and from reducing the inside diameter of the assemblies. For this analysis all samples were measured in some points aiming to reduce the exterior diameter of the pipe, the thickness of the exterior diameter of the ridge and the exterior ridge, figure 5.

After the measurements, there resulted the fact that in the connection area, the pipe diameter area changes according to the parameters of the assembly, its variation being comprised of 0.09 mm up to a maximum of 1.11 mm. The same phenomenon was observed in the case of exterior ridge analysis regarding thickness variation from 0.2 mm to 1.81 mm and its diameter, ranging from 22.55 mm to 26.6 mm.

The variation of thickness and the ridge diameter are indicated in figures 6, respectively 7.

After cutting up the samples, they were subjected to non-destructive examination with penetrant liquids.

A series of images resulted are shown in figure 8.

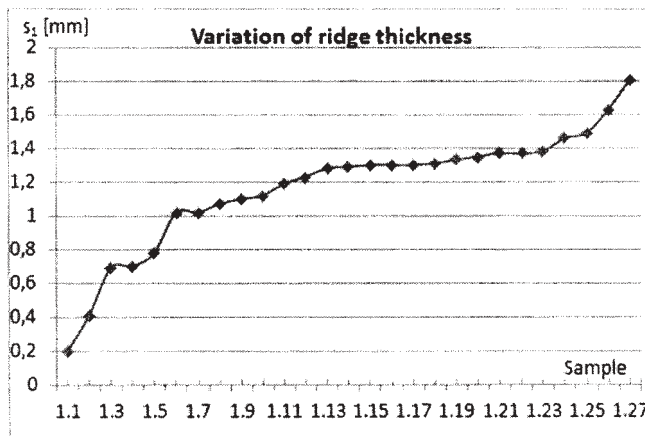


Fig. 7. Variation of the ridge thickness

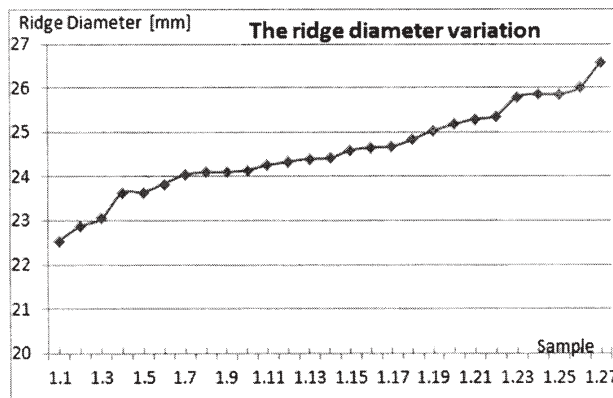


Fig. 7. The ridge diameter variation

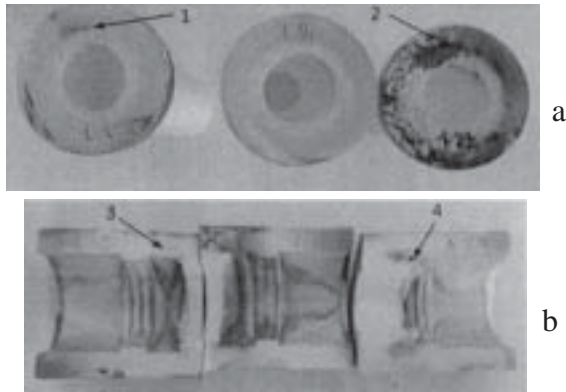


Fig. 8. Images examined with penetrant liquid 1 - the crack of the pipe sample interface 1.1 - socket, 2 - the crack of the pipe sample interface 1.27, 3 the sample socket crack 1.1., 4 - the pipe assembly missing continuity - the sample socket 1.27

To the penetrant liquid examination, we could ascertain the following:

- in the case of 1.1. to the assembly pipe-socket interface appeared a crack due to lack of heat necessary for connection, the phenomenon was found in sample 1.27 which was heated in excess;
- in the case of 1.1 sample, in the socket was accentuated some records of material discontinuities, fig. 8b).
- to the sample examination 1.14, the examination has not highlighted the existence of non-conformity.

### Conclusions

From the result of the experiments and the analysis of the obtained results we may detach the following conclusions:

- the operation of the assembly of pipe-socket type in PPR without insertion is an operation that does not require a very good operator training;

-the quality of the assembly is influenced significantly by the parameters chosen for their realisation and the variation of the shrink is not linear;

- to determine the dimensions of the parts to the assembly, we must take into account their shortening resulting after the assembly. Before the assembly shall be done a verification of the shortening which depends on temperature, time and the press force;

- optimal parameters for assemblies, for the cases analysed, there are those used for realizing the sample 1.14, i.e.  $T = 250\text{ }^{\circ}\text{C}$ ,  $t = 10\text{ s}$ ,  $F = 30$ ;

- before achieving the assemblies it is important to verify the assembly parameters even if they are recommended by the manufacturers.

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