

DEFECTS OF COMMUNICATION PIPES FROM PLASTIC IN MODERN CIVIL ENGINEERING

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ABSTRACT

Plastic is an important material that is used in civil engineering. Communication pipes - one of the directions of use of plastic. The external environment affects the quality of the use of plastic pipes. Therefore it is important to know the defects of plastic products. It is also necessary to make assessment of the quality of the use of plastic pipes. It depends on many factors. Therefore the task of detection and preventing of the communication pipes defects - the complex task. We did a survey of the major defects of the communication pipe. We have examined the factors that influence the formation of defects in the communication pipe. A classification of variable factors that affect the quality of communication pipes is proposed. A generalized algorithm for evaluating the quality of communication pipes has also been developed.

KEYWORDS: Defects, Plastic, Communication Pipes, Quality & Assessment

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INTRODUCTION

No modern building (as intended for housing, performance of administrative functions or commercial structures) can practically be presented without the systems of communication therefore pipes for the sewerage, water supply, heating are so demanded.

The leading place in the modern market of building materials by production of communication pipes is taken by plastic. Plastic, plastics – materials on the basis of polymers, capable to get the set form when heating under pressure and to keep it after cooling. May contain fillers, softeners, stabilizers, pigments, lubricants, etc. components. Depending on the nature of the transformations happening to polymer at his processing in a product are subdivided into thermolayers (the most important of them – plastic on the basis of polyethylene, polypropylene, polystyrene, polyvinylchloride, polyamides, polycarbonates, a politetraforetilen) and reaktoplasta (the most large-capacity look – phenoplasts, are widely used also plastic on the basis of epoxy resins, polyester pitches, the kremniyorganicheskikh of polymers, etc.) [1-3].

In modern civil engineering exclusively corrosion-proof materials are applied to laying of new communication systems: plastic pipes, polyvinylchloride pipes (PVC), products from polypropylene, corrugated analogs, etc. [4].

Imply plastic pipes: polyethylene (PE), polypropylene (software), PVC of system of pipelines. Plastic pipes possess a row of advantages before the metal analogs. First, they are long-lasting, secondly, are simple in mounting and maintenance, thirdly, have available cost. In most cases PVC replaces traditional construction materials, such as wood, metal, concrete and clay. When mounting a water supply system use polyethylene pipes, however they are applicable only for cold water. If the system provides existence of high temperatures, then it is better to select metalpolymeric models. Such pipes do not need additional insulation and perfectly transfer the most different temperatures, their single shortcoming – high cost. That is, products shall correspond completely to conditions, and laying down of the high-quality pipeline requires strict observance of all rules and nuances of mounting. In case of a pipes material choice their assignment is significant.

The task of detection and preventing of the communication pipes (CP) defects – the complex task as the quality depends on many factors, beginning from a choice of material and process of their manufacture and finishing with pressure testing of ready connections. Criteria for making decision on prevention of defects are results of the set factors statistical analysis, the conditions influencing quality.

The most important requirements to production such can be considered compliance to the highest quality standards and operational characteristics, that is, pipes shouldn't be exposed to corrosion, collapse under the influence of aggressive factors.

MATERIALS AND METHODS

Traditional Approaches to Determination of Communication Pipes Defects

Today the problem of plastic products defects and ways of their elimination is solved in many works devoted to identification of such incidents it can be very useful to monitoring, safety, maintenance, modernization and management of life cycle of pipelines.

Works [1-3] are devoted to a communication research between processing parameters both technological and operational properties of the received polymeric materials and also solutions of the tasks connected with application and fastenings of polymeric pipes are considered. Authors describe ways of plastic products connection and key parameters for calculation of building constructions from plastic.




In [4] contains information including numerous tabular and graphics of numerous examples of the refusal actual cases in pipelines, photos of pipes defects, the compressed description and diagnostics of an event of refusal. Development of plastic pipes processes production, studying of technological process influence on quality of these products it is presented in [5]. The questions connected with properties of plastic pipes at different types of impact on them are considered. The problem of plastic pipes deformation and ways is also in details opened. In [6, 7] main attention it is paid to development and assessment of the researches directed to improvement of quality.

Review of the Main Defects Communication Pipes

Defects of plastic products can be a consequence of their manufacture process or arise in process mounting and maintenance. Anyway it is necessary to begin with external examination and diagnostics of the damaged section.

The quality, speed and cost of carrying out future repair will depend on type of defect directly. There are several main types of damage of the plastic pipes given in Table 1 [1, 3-5].

Table 1: Main Defects of Communication Pipes

No	Defect	Images	Possible causes
1	Complete or partial separation of a pipe		Emergence of gaps is usually accompanied by careless work near an arrangement of the route pipeline
2	Leak in connection knots		The leak in knots and places of connections isn't damage, and is caused by violation technology of the device of welded connection. Also can be a consequence of improper use materials at their device
3	Suppression		Arises at installation of plastic pipes

The Factors Influencing Formation of Communication Pipes Defects

The reasons of emergence pipes defects from plastic have very various prerequisites.

At design of pipelines it is necessary to consider a number of plastic pipes characteristics in comparison with traditionally applied metal, namely[4, 6, 7]:

high corrosion resistance to the vast majority of the transported and soil environments in the absence need of their additional anticorrosive protection;

considerably the smaller weight facilitating and simplifying hoisting-and-transport and construction;

the big flexibility of pipes allowing to reduce number of bent inserts;

- smoothness their internal surfaces, reducing the hydraulic resistance to a stream.

It is defined what influences quality of pipes:

- The incorrect choice of material for pipes production.
- Use of low-quality raw materials.

- Incorrect choice of manufacturing techniques.
- Violation of pipes manufacturing techniques, it is possible to allocate two major factors influencing process of pipes production: production temperature, speed of a pipe extension.

If for some reason plastic fusion temperature too high, then material begins to boil begin, as a result the pipe turns out porous that is especially visible at a facing.

The surface of such pipe is covered with ruts, and the pipe can't sustain the stated pressure.

Significantly the speed of plastic fusion influences quality extension of pressure head pipes [8]. If the producer wants to accelerate process of a pipe production, he increases the speed of extension, pipes is made for shorter time, than usually, but the quality of this pipe leaves much to be desired.

Such pipe has a rough surface, and wall thickness in such pipe fluctuates, as a rule, the wall in such pipes becomes thinner. It happens because of uneven raw materials supply.

Also pipes cannot maintain necessary pressure and also be torn at their use.

- Incorrectly set parameters of the industrial equipment (IE) participating in process of pipes production.

At the same time it is necessary to consider number restrictions for application of the plastic pipes determined by properties of plastic [4, 5]:

- Temperature of the environment coming to the pipeline has to allow her transportation in viscosity parameter. Temperature of the pipeline has to meet the requirements to durability, stability, deformability and reliability. The chemical firmness of a pipe material under operating conditions of the pipeline has to be provided.
- The transported environments and a design of the pipeline have to exclude a possibility of the pipeline obstruction in the form of pollution or crystallization.
- Corrosive attack of the transported product or the external environment to metal elements of the pipeline has to be prevented by active or passive methods of protection.
- Pipelines should be laid mainly underground (underground laying). Other types of pipelines laying – on the Earth's surface in an embankment (land laying) or on support (elevated laying) – are allowed at technical need and the corresponding justifications. It is necessary to provide the actions providing their reliable and safe operation.
- Laying of pipelines has to be carried out, as a rule, by the principle of corridor laying, parallel to other operating or designed pipelines transporting the same product.

Thus, violation of the production technology, use of low-quality raw materials – the main reasons of shortcomings. As a rule, these shortcomings are inherent in parts of pipes which haven't undergone quality control because serious producers turn out products according to standards, and don't allow even the smallest errors.

RESULTS AND DISCUSSIONS

Assessment of Quality of Communication Pipes

Optimization of plastic details quality isn't always adequate to quality of the delivered materials, semi-finished products, preparations and simple performance by personnel in a workplace of all provided operations in full accordance

with requirements of control documentation. Quite often the greatest effect can be reached as a result:

changes of a design of processing equipment;

the correct definition of technological process operations and parameters of the details subjected to control.

In view of a CP designing process it is possible to develop an algorithm of CP quality assessment indicators on the basis of the integrated approach providing quality of production (Figure 1).

In case of production of CP under pressure the assessment generalized algorithm of their quality has the following semantic stages:

- Process of the technical solution (TS) acceptance on improvement of quality begins with operation of finding solutions in the massif of the accumulated experience of information databank. If solutions are found, then we enter information if isn't present, there is a repeated loading of data.
- Wording of requirements to CP. It is important to correctly formulate requirements to CP. Requirements imposed to operational qualities of products are offered to be divided into three main groups: appointment, reliability and esthetics, but the general and the main will be the validity of CP.
- Choice of quality indicators (personal computer). It was carried out on the basis: definitions of appointment and use conditions of CP; analysis of consumers requirements; structure and structure of the characterized devices; main requirements to the personal computer. From here, the list of CP quality indicators is defined: roughness, density, durability, hardness.
- Choice of the basic indicators nomenclature quality of CP.
- Choice of values determination method quality indicators of CP. This method will allow carrying out objective assessment and also expression of results in the standard measure units that is convenient for comparability and reproducibility of results.

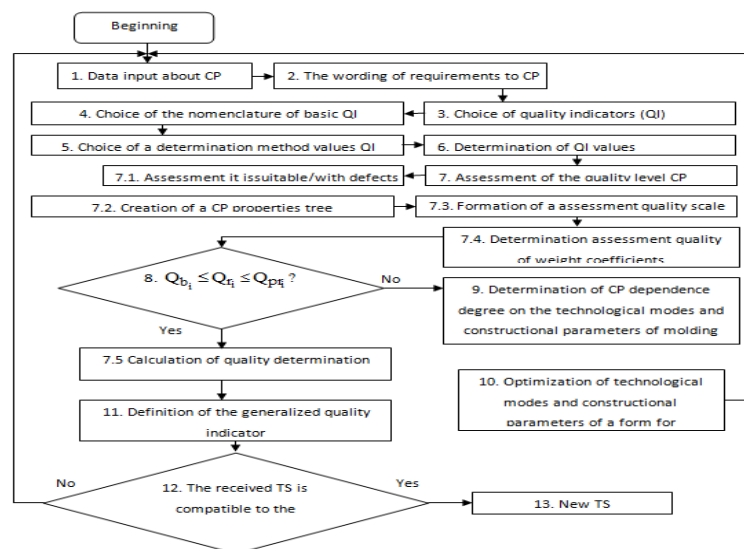


Figure 1: The Generalized Algorithm of CP Quality Assessment

- The determination of the quality CP values.
- The evaluation of the quality level CP.
- For a start it is proposed to evaluate from the point of view defect, for this we evaluate the number of detected defects (checking for performance of the basic requirements for CP).
- Building the tree all the properties of quality metrics [7].
- Formation of scale quality evaluation. Central to the estimation procedure is the construction of qualitative scales.
- Definition of weighting coefficients of quality evaluation. To determine the importance rating used a scale from 0 to 1; 1 – high importance.
- Calculation of an error of determination quality CP.
- Check of conditions (criterion of quality) Q_{r_i} – the i -th value of an quality indicator of the estimated CP has to be in the range. If the condition is satisfied, then point 7.5 – assessment of an quality level error is implemented. If the condition isn't satisfied, then transition to point 9:
- The sizes of plastic CP have to be in the range where – the CP sizes where $i=1 \dots 4$, 4 – the number of the parameters determining the CP size (1 – width (B); 2 – length (L); 3 – volume of casting (V); 4 – thickness of a wall of H(S)).
- 7-8 classes.
- Determination of durability, density and hardness.
- Determination of CP dependence degree on the technological modes and constructional parameters of molding forms Determination of the CP sizes accuracy (kvalitt). It is recommended to appoint the accuracy of the plastic CP sizes within 5 – the 7 th classes. The same way accuracy for CP is defined.
- Definition of the molding form dimensions.
- Determination of non-failure operation and durability.
- Determination of surfaces roughness. The roughness of the plastic details surface made by casting under pressure and pressing corresponds to
- Optimization of the casting technological modes and constructional parameters of a compression mold.
- Definition of the generalized quality indicator.
- Compatibility analysis to the specifications. The highest quality of CP – by simultaneous optimization of the technological modes and the MF constructional parameters[7].

Classification of the Variable Factors Influencing Quality of Communication Pipes

In this article we will consider the reason of existence / appearance defects from the view point of CP manufacture process (formation process by a injection method under pressure) and as a result of mounting.

We will consider the task of receiving qualitative production which decision is determination of the most significant parameters / factors of CP formation process and its dependence on them.

Let the changing characteristics of raw materials (plastic material), technological process and features of the injection molding machines (IMM) (hydraulic and electrical IMM drives, a node of plastication and injection, a node of interlocking molding form) will be these factors.

We will separate all parameters / factors on input, the intermediate, output and target. We will allow input variables consist of the adjustable and nonadjustable (perturbing) variables. Input adjustable variables are factors which are set by the operator on the appropriate devices regulating process that is, it is possible to influence them directly.

The nonadjustable (perturbing) variables are parameters of casting process which it is impossible to influence during a casting cycle (a machine operation mode, the characteristic of raw materials, location temperature, air humidity, oscillations of tension in the power supply network).

Impact on the process of unregulated variables leads to incomplete "reproducibility" of quality indicators CP. Intermediate variables output parameters that are defined at the end separate (or multiple) stages of the casting process (performance plasticizing pressure in the form of the injection and holding pressure; cycle time, power consumption). Output variables describe the stabilization level (accuracy, time) of the input and intermediate variables of the processes. They depend on the stability of the entire process.

Note that intermediate variables of the casting process, almost all interconnected. Thus, the change in the melt temperature in the nozzle leads area to a change in pressure and injection rate, the latter effect at the time of the holding pressure and cooling. This significantly complicates the process control.

Target variables allow you to assess the quality of the casting process and its efficiency (energy, time, material and quality of the CP).

Many of the variable factors can be calculated. But such variables as the viscosity or the geometrical characteristics of the casting (mold) cannot be considered or calculated in advance. This greatly complicates the analysis process and introduces uncertainty in the optimal values selection of variables injection process. The independence of variables allows you to set the IMM the relevant parameters independently from each other. However, this does not mean that they are not connected. On the contrary, a change in one variable can cause a change in another, and neglecting the relationship of variables can lead to violation of the real process. For example, injection pressure, feeding pressure, injection speed, cycle time of a casting depends on the temperature of the melt in the cylinder and the whole process of plasticizing, so they can be considered intermediate variables, although they can be set arbitrarily. All this is reflected in the proposed variables classification of the injection process shown in Figure 2.

In Figure 2 parameter: p_{kp} – pressure in a plastication node before injection; S_{kp} – value of a relocation plastication node; v_{kp} – speed value of a relocation plastication node; T_z – temperature of the IMM cylinder zones; p_{cp} – counter-pressure in case of plastication; n – rotating speed of the screw; S_d – relocation of the screw in case of a dosage; T_w – water temperature, cooling liquid; Q_w – a consumption of the water cooling a molding form; p_f – pressure of a locking molding form; S_f – movement of a molding form when closing; v_{cf} – speed of mobile (semi-form) movement

when it closing; OD – other entrance data; p_{in} – injection pressure of the melt; p_{re} – pressure feeding; v_{in} – fusion injection speed; t_{in} – injection time; t_h – hold time under pressure; t_{co} – casting cooling time; t_{ps} – time to pause during the process of forming; F_{cn} – pressing force of a nozzle to a molding form; t_{kp} – movements of plastication knot; T_n – temperature of the melt in the nozzle; ΔT_n – change (distribution) of the melt temperature; η – viscosity of the melt; t_{pl} – plastication time of one-time injection volume; E_{pl} – energy of the plastication; T_{cw} – temperature of a forming cavity wall; E_{cw} – the energy consumption for temperature control; $\Delta p_{m.f}$ – pressure change in the injection form in time; $\Delta T_{m.f}$ – temperature change of the melt in the injection molding form in time; Δp_n – the pressure change in the nozzle of injection molding machines; s_{bl} – thickness of the retaining layer; Δp_{hs} – change in hydraulic pressure in time.

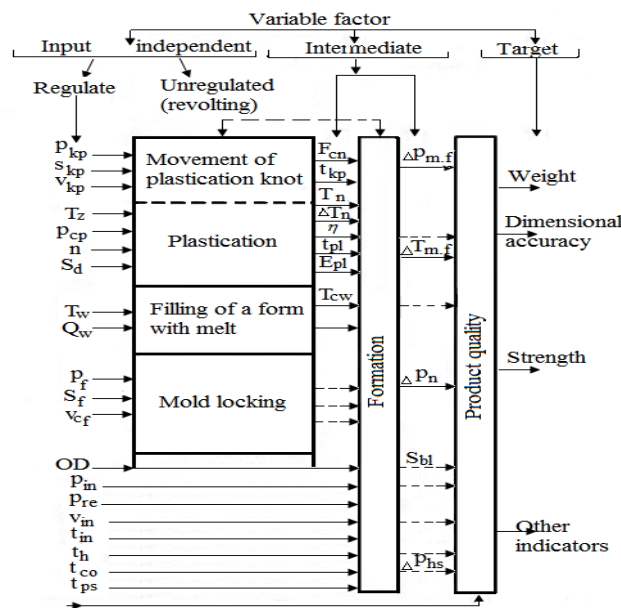


Figure 2: Classifications of Injection Process Variable Factors

As the variables of the process are regulated and managed, then the emphasis should be on those factors that characterize the state of the polymeric material at various stages of the injection process or characterize the impact of components on the polymeric material. Inputvariables: $n, T_z, S_d, p_{in}, Q_w, T_w, v_{in}, p_{re}, t_h, t_{co}$

Treatintermediate: $T_n, \Delta T_n, t_m, t_{pl}, T_{cw}, \Delta p_{m.f}, \Delta T_{m.f}, \Delta p_{hs}, s_{bl}$.

For determination of the output variables considerably influencing stability of injection process and quality of products it is necessary to show correlation of the input and intermediate variable factors given above.

As now requirements to improvement of quality and increase in accuracy of products from plastic constantly increase, the solution of this task is regulation and management – impact on a condition of material, realization of state interrelation characteristics with products indicators of quality (for example, the dimensional accuracy, shrinkage, etc.).

A generalized algorithm for evaluating the quality of CP, which can be the basis for developing a method for assessing the quality of plastic products. The developed algorithm contains a sequence of stages to determine the quality of the plastic components and identification of technological parameters forming process the plastic elements of CP and

moulds, which directly affect the quality of the CP scan. A classification of the injection molding factors process differs from the existing ones that it split factors is from the perspective of regulated / unregulated. In general allows to determine all the important factors that directly affect the appearance of the defect for the purpose of control and by preventing.

CONCLUSIONS

As a result of the communication pipes defects review is determined that the surface defects due to irregularities during assembly. Defects tolerances and poor mechanical properties of products due to violation of pipes manufacturing techniques, the main factors are temperature and production speed of the traction pipe. Based on the analysis of the factors influencing defects of CP presented a generalized algorithm for evaluating the quality of CP and the classification of the variables injection process to ensure stable quality CP. Thus, the main cause of communication defects may be defects, "received" when they are forming, unnoticed during inspection. The quality of the products plays a key role, as the repair is often linked to the implementation of costly works.

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REFERENCES

1. K. Flaga, 2000, "Advances in materials applied in civil engineering", *Journal of Materials Processing Technology*, 106(1), pp. 173-183.
2. L. Janke, C. Czaderski, M. Motavalli and J. Ruth, 2005, "Applications of shape memory alloys in civil engineering structures – overview, limits and new ideas", *Materials and Structures*, 38(5), pp. 578-592.
3. G. A. Antaki, 2003, "Piping and pipeline engineering: design, construction, maintenance, integrity, and repair", *CRC Press*.
4. M. Farshad, 2011, "Plastic pipe systems: Failure investigation and diagnosis", *Elsevier*.
5. T. J. McGhee and E. W. Steel, 1991, "Water supply and sewerage", *New York: McGraw-Hill*.
6. M. S. Huang, 2007, "Cavity pressure based grey prediction of the filling-to-packing switchover point for injection molding", *Journal of materials processing technology*, 183(2), pp. 419-424.
7. S. Sotnik, R. Matarneh and V. Lyashenko, 2016, "System Model Tooling For Injection Molding", *International Journal of Mechanical Engineering and Technology*, 8(9,) pp. 378–390.
8. S. Patcharaphun and P. Jariyatammanukul, 2010, "The effect of thickness on the weld-line strength of injection-molded thermoplastic composites", *Polymer-Plastics Technology and Engineering*, 49(13), pp. 1305-1309.
9. Khan, A., Joshi, S., Ahmad, M. A., & Lyashenko, V. (2015). Some Effect of Chemical Treatment by Ferric Nitrate Salts on the Structure and Morphology of Coir Fibre Composites. *Advances in Materials Physics and Chemistry*, 5(01), 39-45.
10. Khan, A., Ahmad, M. A., Joshi, S., & Al Said, S. A. (2014). Abrasive wear behavior of chemically treated coir fibre

- filled epoxy polymer composites. American Journal of Mechanical Engineering and Automation, 1(1), 1-5.*
11. Alveera, K., Mohammad, A., Shirish, J., & Lyashenko, V. (2015). *Dielectric and Electrical Characterization Study of Synthesized Alumina Fibre Reinforced Epoxy Composites. Elixir Crystal, 87, 35801-35805.*
 12. Ahmad, M. A., Lyashenko, V. V., Lyubchenko, V. A., Khan, A., & Kobylin, O. A. (2016). *The Methodology of Image Processing in the Study of the Properties of Fiber as a Reinforcing Agent in Polymer Compositions. International Journal of Advanced Research in Computer Science, 7(1), 15-18.*
 13. Lyashenko, V. V., Ahmad, M. A., Lyubchenko, V. A., Khan, A. & Kobylin, O. A. (2016). *Image Processing a New Era in the Study of Natural Polymer Composites. Asian Academic Research Journal of Multidisciplinary, 3(3), 288-300.*
 14. Putyatin, Y. P., Ahmad, M. A., Lyashenko, V. V., & Khan, A. (2016) *The Pre-Processing of Images Technique for the Material Samples in the Study of Natural Polymer Composites. American Journal of Engineering Research, 5(8), 221-226.*
 15. Lyashenko, V., Kobylin, O., & Ahmad, M. A. (2014). *General Methodology for Implementation of Image Normalization Procedure Using its Wavelet Transform. International Journal of Science and Research (IJSR), 3(11), 2870-2877.*