A solution is proposed to the problem of lifetime in pipeline equipment. The principle is proposed for splitting up the functions of the pipeline components when the lines contain abrasive media. A theoretical basis is provided for the design of a sharp bend in a steel pipeline with the aim of improving the wear resistance.

Most existing pipeline systems in various industries are equipped with components for controlling flow, namely throttling and regulating devices, and also by the different diameters $D_c$ of the conditional throats. For small ones ($D_c \leq 300$ mm), there are characteristically elevated flow speeds, so any fine-grained solid components (often irremovable for various reasons) reduce the actual working life of those components.

In particular, current petroleum equipment is composed of steel pipeline components, whose intended working life is years or even decades.

Specifications by the Gazprom Company indicate that the working life of components of that form should be not less than 30 years (there is a demand to increase that time to 40 years). However, the petroleum industry has various forms of equipment in which mechanical impurities occur in the working media almost inevitably in excess of the permissible concentrations.

Although one uses chemical, physicochemical, mechanical, and combined methods of dealing with the escape of sand from boreholes, there is no reasonably effective solution to this problem. The gas, condensate, or oil and the drilling and washing solutions contain products from the petroliferous strata and other mechanical impurities (corrosion and erosion products, mineral dust, contents of filters, welding sludge, and so on), and these make it necessary to use various cleaning systems in the extraction, transportation, storage, and processing of those working media.

Pipe fittings in the oil industry are composed mainly of small elements designed for high-pressure use ($p_c \leq 6.4$ MPa). They include wedges, washers, and rotating components, as well as ball valves and multiway valves, and regulating valves, unregulated and regulated inlets, and sharp bends in pipelines. The maximal superficial and deep damage to such components is localized in zones where the direction of motion changes or where there is a corrosive current of the working medium (Fig. 1). The failure cause is the abrasive erosion, which occurs in the accelerated flow containing mechanical impurities, so their actual working life is reckoned in hours or at best in days.

Commoner means of protecting working components used by manufacturers:

- arc coating (for example, plasma coating with self-fluxing nickel-chromium alloys of PR-NKh16SR3 type, hard alloys of VK-8 type, or stellites on the surfaces of throttles and valve washers);
- thermochemical treatment (for example, nitriding or nitrocementation of slide valve components);
- electrochemical coating (for example, hard chromium plating of ball valves).
No appreciable increase in working life has been obtained from attempts to increase this on the basis of strengthening the parts where wear occurs. On the other hand, it has quite long been known that it is necessary to consider the hydrodynamic circumstances.

Systematic studies have been made on failures in pressurized parts of underground stores for natural gas or in compressor stations handling petroleum, where a systems approach has been employed. It has been proposed to distinguish the abrasive erosion system of pipeline elements for unspecified sets of abrasive-bearing flow and obstacle material, with the interaction of the flow with the functioning device.

The traditional systems approach has meant that the functions of the components may be analyzed with reference to a classical regulating device (slide valve), where one assumes not as usual that there are two functions of the device (shutting off the flow and opening up the flow to the pipe), but instead three: partial shutdown, i.e., reducing the flow rate to an acceptable regulated minimum; providing the sealing performance of the shutoff flow specified by standardization documents; and opening up the pipeline flow. These functions are related to the behavior of the interacting subsystems, and it is possible to relate the damage to the device from the abrasive-bearing flow to the design.

This has led to a particular principle for separating the functions: the surfaces that serve to regulate the flow in the item should not participate in the valve sealing. This principle is a constructive means of extending the working life of these pipeline devices for flows containing mechanical impurities.