WIERTNICTWO NAFTA GAZ TOM 22/1 2005

Alexeiy A. Kuleshov*, Yuriy D. Tarasov*, Vadim P. Dokoukin*, Alexander K. Nicolaev*

DYNAMIC LOAD COMPENSATION AT USAGES OF OIL AND GAS PIPELINES

For Russia the questions of economical portage of minerals are especially actual, because the basic districts of their bedding and consumption, as a rule, are parted by considerable distances. A pipeline transport is the most perspective and ecofriendly type of moving of oil, gas and other minerals. This type of transport allows fully to automatize all process of moving of pay load.

Greater part of sources raw of materials of country is in districts, which are characterized by not only severe climatic terms but also presence of amictic soils and seismic overactivity. Districts, where the earthquakes are possible by intensity 6–10 marks on the scale of MSK-64, make 28.6% from territory of the CIS. Therefore among the row of problems in mastering of minerals the problem of providing of reliability is major and ecological safety of pipelines due to the exception of violation of his integrity.

Depending on combination of climatic terms, relief, technologies of building and modes of portage, mainlayings satisfying to the requirements of defence of environment apply different types. Pressures pipelines in the process of exploitation are exposed to influence of row of power factors which in one or another degree influence on their bearing ability, determining the level of reliability of exploitation. To the number such factors belong: intrinsic pressure, temperature tensions, bend of pipeline on relief localities, hydraulic shots transitional modes and etc In the ordinary terms of gasket the calculation of above-ground and underground pipelines is limited to determination of thickness of walls of pipes, coming the size of intrinsic pressure and corrosive processes from. However, at the considerable seasonal overfalls of temperatures of outward air, and also natural and technogenic seismic influence such method of calculation is insufficient, because in this case pipelines undergo action of additional static and dynamic forces which in the metal of pipes and on connections cause considerable tensions.

* Saint Petersburg State Mining Institute the name G.V. Plekhanov, Technical University

For prevention of failures of gaz – oil pipelines related to violation of integrity of pipes as a result of influence of seismic forces or temperature tensions, it is necessary yet on the stage of planning to choose the most expedient structural variant of mainlaying. This task can be decided during realization of hardwares which are developed for the transport of friable loads, but suitable and for gas pipelines.

On the basis of the researches executed in SPMI, dependences are offered for the calculation of parameters of seismic influence on the pipeline fastened on supports, the vibrations of which are composed from a transversal and longitudinal constituent. It is considered that the effect of seismic influence concernes by not only intensity of shock wave but also correlation of duration of action of pressure of wave with the period of eigentones of pipeline. When duration of action of pressure of wave the considerably less than period of eigentones of pipeline, size of his deformations caused by the action of waves of seismic influence, concernes in size the impulse reported by front of shock wave. It is therefore natural to assume that the size of this impulse must be accepted as a criterion destroying forces. After influence of single impulse there is his fading (the reiteration is very rarely). The type of seismic influence of R(i) depends on speed of growth of shock wave. Form to the curve of growth (in accordance with present information of supervisions) can be approximated by the function of hyperbolical sine.

$$R(\ ) \quad \begin{matrix} sh \\ sh \quad _k e^{-\ (\ -\ _k)}, \end{matrix} \qquad \begin{matrix} _k \\ _k \end{matrix}$$

where   = 0.45 (the value   is got empiric).

Equalization of oscillation of pipeline taking into account looks like the curve of bend

$$a^2 \frac{^4 Z}{x^4} \quad \frac{^4 Z}{^4} \quad - \frac{1}{s} R(\ ),$$

where:

$Z = Z(x,\ )$	–	vertical displacement;
a^2	=	$EJ/(\ s)$;
EJ	–	flexion inflexibility;
	–	closeness of element of pipeline;
s	–	area of crossrunner of pipeline.

A regional task consisting of the indicated equalizations and regional terms can be decided both analytically and by the numeral design on a computer.

Taking into account the executed researches the row of structural decisions of connection of elements of pipeline, which are protected by the patents of a Russian Federation, is developed in SPMI.

On one of variants the device for extinguishing of vibrations of pipeline (Fig. 1) contains the foundation, connected with a pipeline by pliable adaptation, which is executed as bearing basket of cylindricity, coaxially wrap-round a pipeline and supplied in overhead to the part by the union coupling with a lid. Internal space between the outward surface of pipeline and basket is filled by close adjoining to each other, to the surfaces of basket and pipeline by the bodies of spherical form, made from resilient material. The mentioned bodies are accommodated in one row on the perimeter of pipe. A basket is executed sectional on a generatrix cylindrical surface and supplied by flantsevym connection, and the diameter of openings in the butt-end walls of basket is accepted more external diameter of pipeline with possibility of placing in the circular crack gaps of resilient gaskets. In case of occurring of the forced and own vibrations of pipeline, caused by the seismic phenomena, the outward surface of pipeline begins to co-operate with resilient balls which, resiliently becoming deformed between the outward surface of pipeline and internal surface of basket, quickly extinguish his vibrations. The reaction of basket is perceived by foundation.

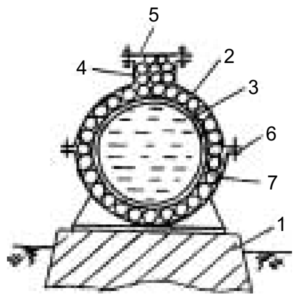

Fig. 1. Device for extinguishing of vibrations of pipeline: 1 – foundation, 2 – basket, 3 – pipeline, 4 – union coupling, 5 – lid, 6 – connection socket, 7 – resilient balls

In other construction anchor support (Fig. 2) contains foundation, two antivibration supports, saddle. Every antivibration support is executed as connected with a saddle and collar of flat spring having an elliptic type in a vertical plane.

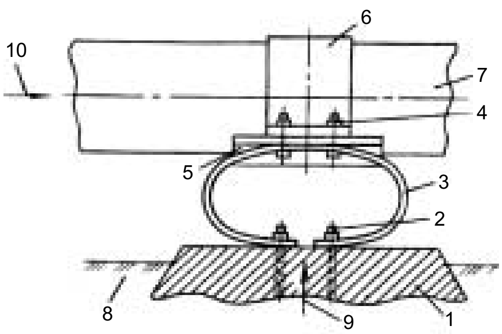

Fig. 2. Anchor support springing as: 1 – foundation, 2 – screw-bolt, 3 – springs (two), 4 – timber screw-bolt, 5 – saddle, 6 – collar, 7 – pipeline, 8 – soil, 9, 10 – directions of seismic influence

The static loading from pul'povoda is passed on a saddle and further on its springs, leanings against the foundation stopped up in soil. At seismic influence of soil on foundation the springs connected with a saddle bend in the proper plane at the vibrations in different directions, reducing the size of acceleration at moving of pipeline and loadings proper by him. At the vibrations in transversal direction in relation to a pipeline one of springs is straightened, and the second compresses in a vertical plane. Thus, at any direction of seismic influence a pipeline begins to hesitate with the attenuation on a size accelerations eliminating water-hammers and his mechanical destruction. Such office hours allow to promote reliability of exploitation of pipeline and his longevity.

At seismic influence on the pipeline fastened on supports, the vibrations are composed from a transversal and longitudinal constituent. Except for it at the hard enough method of connection of pipes formings a pipeline, in the last at distribution of waves of vibrations and laying on them one on other, a difficult swaying process is possible with the resonance phenomena, the parameters of which practically are not added to mathematical description from complication of physical model. And it does impossible grounded to choose the structural parameters of pipeline, adequately proper to the really nascent loadings in his elements. A technical task can be decided by offered by us elastic docking of pipes (Fig. 3).

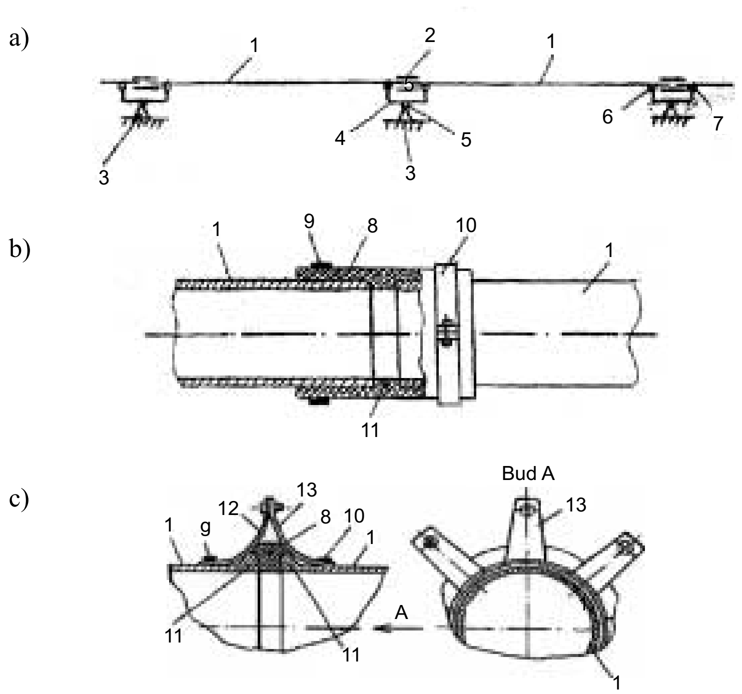

Fig. 3. Elements of docking of pipes: and is chart of pipeline: a), b), c) – variants of connection pipes by elastic muffs; in – that, by flange connection, 1 – pipes, 2 – resilient connecting elements, 3 – support, 4 – equalizer, 5, 6, 7 – hinges, 8 – resilient muff, 9, 10 – bracers, 11 – flowing, 12, 13 – resilient flantsy

The elastic connecting elements of pipes hinder to passing of wave from one pipe to other. It provides extinguishing of vibrations of contiguous pipes in elastic connecting elements, as the module of resiliency of material which transitional elements are executed from is accepted less than module of resiliency of material of pipes formings the thread of pipeline, and the ends of pipes can freely turn in relation to each other due to their leaning against an equalizer which by hinges and related to the pipes and with support. Such decision allows to eliminate the cross-coupling of swaying processes arising up in the contiguous areas of pipes, that enables to make prochnostnoy calculation of pipeline for the models of the singlebay beam on two supports, loaded with revolting forces.

Exception of destruction of pipeline in the middle of flight between supports at strong seismic influence it is possible to obtain by the simple device, executed as fastened on a pipeline in the middle of flight between the supporting devices of collar, which by a spring or complete set of springs is related to proushynoy of the pile fastened in an earthly surface, here frequency of eigentones of spring (or complete set of springs) is accepted to aliquant frequency of eigentones of pipeline in flight between the supporting devices. The increase of reliability of exploitation of pipeline is the result of technical decision in seismically dangerous regions due to diminishing of amplitude of vibrations of pipeline in flights between the supporting devices.

CONCLUSION

The method of calculation of pressures pipelines is offered taking into account the seismic loadings and the construction of elastic connection of areas of pipes is developed.

The row of structural decisions of gasket of gazo- of the oil pipelines, protected by the patents of Russian FEDERATIONS which allow to promote reliability and efficiency of exploitation of pipelines in severe climatic terms and at seismic influence on them, is developed.

REFERENCES

[1] Support of pul'povoda (variant). Patent No. 2147688, 2000, No. 11
[2] Scray of change of length of pul'povoda. Patent No. 2168667, 2001, No. 16
[3] Anchor support of pul'povoda. Patent No. 2168666, 2001, No. 16
[4] Anchor support of pul'povoda. Patent No. 2211393, 2003, No. 24
[5] Device for extinguishing of vibrations of pipeline. Patent No. 2220357, 2003, No. 36