UDC 622.692.4

Investigation of welded pipelines joint fatigue limit with the purpose of their fatigue endurance increasing

Oleg Taraevskyy

PhD in Technical Sciences
Docent of Transport and storage of oil and gas department,
Ivano-Frankivsk National Technical University of Oil and Gas
Ukraine

The gas transport facilities continuous operation under such modes cannot but cause their significant moral and physical aging, i.e. the equipment engineering level discrepancy to modern requirements (e.g. operating reliability index, environmental safety).

Gas motion state in the gas pipe-line is unsteady. In such cases, the pressure oscillations, which may be of periodic nature with certain time damping ratio, occur in the gas pipe-line. The nature of such oscillations can be varied depending on the reasons, which caused them. Such time pressure oscillations lead to stresses cyclic changes in the pipe walls with a frequency, which approximately corresponds to cyclic load diurnal period.

A comparison of appropriate values σ_r, $\Delta\sigma_r$, $\Delta R(P)$, which are obtained according to the tests data with step-load change and by extrapolation using test results of samples with crossing joints, showed that both methods give almost equivalent results. The tolerance fatigue limit corresponding to survival probability 0.99 obtained by extrapolation using the equation becomes stable when the number of samples, which are tested in a limited fatigue area, is 10-15 items. The maximum deviation of the limit determined by ten different random samples corresponding to 10 and 15 samples from the total 120, which are tested at the tension higher than the fatigue limit, from the same limit σ_r set by testing of 40 samples with step-load change on the base 10^7 cycles, did not exceed ± 5% (Fig. 1). In this connection, for the analysis of dependence $\Delta\sigma_r$, $\Delta R(P)$:

$$\frac{(\sigma_r)E}{\sigma_r}, \%$$

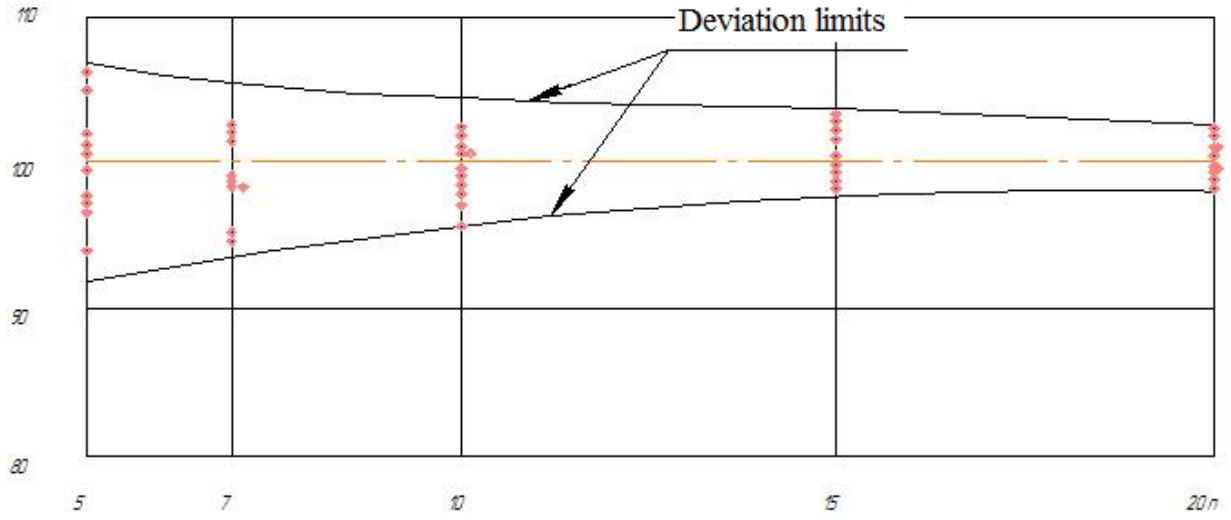

Figure 1. Deviation of fatigue limits, which are obtained by extrapolation, from experimental fatigue limits depending on the samples number

The maximum exceeding of medium fatigue limit above its lower confidential interval when the number of tastings n=20 is only 4.6% (Table. 1).

The obtained deviations $\Delta\sigma_r$, $\Delta R(P)$ do not practically depend on the type of connection and cycle characteristics, which indicate the homogeneity of variance of welded joint fatigue limits. The observed pattern simplifies significantly obtaining of characteristic and design resistance of fatigue failure welded joints.

When determining of fatigue limits average values according to data, the representative sample is enough (corresponding to the tests results of 10-15 samples). As calculation deviations $\Delta\sigma_r$, and $\Delta R(P)$, we can take the average value $\Delta\sigma_r$ and $\Delta R(P)$, which are shown in the Table, and then

$$R_r^C = \sigma_r - \Delta\bar{\sigma}_r$$
$$R_r = R_r^C - \Delta\bar{R}(P)$$

Table 1. The values $\Delta\sigma_r$ and $\Delta R(P)$ for different welded joints

Connection and cycle characteristics	$\Delta\sigma_r$ kg/mm^2	$\Delta R(P)$			$\frac{\sigma_r}{(\sigma_r)^{Д}}$, %
		P=0.950	P=0.970	P=0.990	
Butt r= - 1	0.12	0.49	0.60	0.81	101.8
Surface r= - 1	0.15	0.63	0.65	0.86	104.6
Serface r= 0	0.17	0.73	0.88	1.18	102.5
Connections with crossing joints r = - 1	0.12	0.50	0.61	0.83	101.3
Average value	0.14	0.56	0.69	0.92	-

More often, however, σ_r is determined by building of stability curve in logarithmic or semilogarithmic coordinates.

At that, as the average value of the fatigue limit, the stress level is accepted. This level corresponds to the horizontal curved line $\sigma - N$, which location is usually predetermined by tests result of two samples only. In this case R_t^C defining requires some adjustment.

Conclusion

Testing result of two samples, which determine σ_r, may be different: either only one or two samples undergo given test cycles without failure. In the first case, the stress level, at which these samples were tested, is accepted as the

average value of the fatigue limit. In the second case, σ_r is determined as the average value of two stress levels: level of considered samples testing and the level exceeding the stress, in which at least one sample is destroyed.

References

1. Karpenko G.V. *Prochnost' stali v korozionnoy srede*. [Strength of steel in a corrosive environment]. Moscow, Mashgiz, 1963. 188 p.
2. Krizhanivs'kiy E.I. (2005) Effect of hydrogenation on corrosion-mechanical properties of gas pipelines welded joints. *Rozvidka ta rozrobka naftovikh i gazovikh rodovishch*. No1 (14). p.p. 25-29.
3. okhmurs'kiy V.I. *Koroziyno mekhanichne ruynuvannya zvarnikh konstruktsiy*. [Corrosion-mechanical destruction of welded constructions]. Kyiv, Naukova dumka, 1990. 347 p.
4. Pokhmurs'kiy V.I. Korrozionnaya ustalost' metalov. [The corrosion fatigue of metals]. Moscow, Metalurgiya, 1985. 207 p.