

Hydraulic protection of long distance pipeline in Mountain Area*

ZHAN tingwen, CHEN liqiong, TANG fan, SUN jingyun, SHI yazhou

Abstract—With the rapid development of long distance pipeline in China, the pipeline has no choice but crosses some complex landforms such as Mountain Area. In the river (ditch), slope, mountain, alluvial plain, Pipeline has a high probability of damage. It is an increasingly important problem to adopt reasonable hydraulic protection measures for long distance pipeline in Mountain Area. Based on a large amount of paper reading and practical experience, combined with complex topography of Mountain Area, the article discussed measures of hydraulic protection and summed up the measures of hydraulic protection in Mountain Area according to local conditions to stop soil erosion effectively and reduce operating costs.

Index Terms—Pipeline; hydraulic protection; Mountain Area

I. INTRODUCTION

Recent years, with the increase of Oil-gas long distance pipeline constructions, then the water and soil disaster is concerned gradually by employees. According to Annual of People's Republic of China, China's mountain area accounts for two thirds of the total area. As for the biggest area, mountain area becomes the most popular for oil-gas pipeline construction in complex landform. So it is very important for the search of hydraulic protection for mountain area. For example, gas pipeline of the west is about 1,800 kilometers long. There are about 1,900 hydraulic protections, which means that there are more than one per kilometer. Compared with other professional fields related with long distance pipeline, the technology development for design and construction of hydraulic protection projects can not match with the development of pipeline net. Based on large amount reading of documents of home and abroad, the article systematically and comprehensively reviewed the laying form of long distance pipeline and hydraulic protection in Mountain Area.

II. LAYING TYPES AND FAILURE FORMS

2.1 pipeline laying in mountain and river

1) pipeline crossing the river

pipeline crossing the river refers to the pipeline crosses the bottom of river(ditch), shown in fig.1. According to construction technology, crossing pipeline is divided to open cutting, directional drilling and tunnelling crossing, which related to different hydraulic protection problems. However, there are two hidden troubles. First when waterstead continually washes the undercut, the pipeline under the riverbed may be naked and hung in the air. The channel scouring will lead to pipeline break; second the erosional retreat will expose and damage the pipeline in the climbing.

For the former, the hydraulic protection of crossing pipeline is to prevent the continually scouring of riverbed(ditch). For the latter, it needs to protect river bank from continually retreating to avoid pipeline exposing for pipeline security.

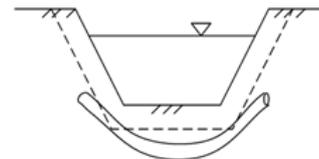


Fig.1 pipeline crossing the river

2) pipeline along the river bank

pipeline along the river bank refers to pipeline is laid aside by and parallel with the river(ditch) bank, shown in fig.2. this laying form doesn't intersect with the river(ditch) bank, but because of crashing and retreating of the river(ditch) bank, it will cause long pipeline to rise and hang in the air. it needs to adopt hydraulic protection measures to protect the river(ditch) bank.



Fig.2 pipeline along the river bank

3) pipeline along the bottom of river

Pipeline along the bottom of river is shown in fig.3. this is usually applied to seasonal river(ditch) bank. It is usually constructed in the low water period. This laying form does not intersect with the river(ditch) bank, but during the flood season, the riverbed continually in cutting trend, it also will cause long pipeline expose in the air.



Fig.3 pipeline along the bottom of river

2.2 pipeline along with mountain slope

1) pipeline crossing the hillside

As pipeline crosses the hillside(parallel contour), shown in fig.4, it will cause two accidents. First the outside weak

soil of the ditch wall and backfilling erosion cause pipeline expose and hang in the air; second the blasting disturbance while excavating trench will cause soil landslides or collapsing. It belongs to paroxysmal geologic hazard, which has a greater harmfulness to pipeline. It will bring deformation to pipeline because of extrusion. Or it will fill the shaped pipe trend.

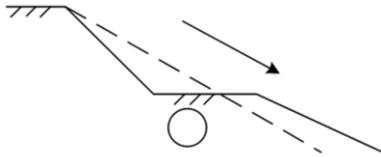


Fig.4 pipeline crossing the hillside

2) Pipeline along the hillside

When pipeline (vertical or oblique crossing contour) lays along the hillside, as shown in Figure 5, under the continually scouring of runoff catchment, the backfill of trench become most prone to slope erosion, causing the pipe roof covering gradually thinning until it all depleted, which can cause pipelines hang in the air as it becomes severe.

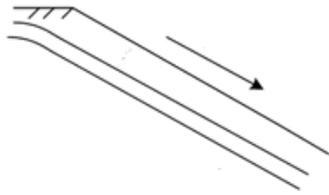


Fig.5 pipeline along the hillside

III. TYPICAL HYDAULIC PROTECTION MEASURES

According to the summaries of construction experience of long pipeline hydraulic protection for many years, the hydraulic protection devided to three categories, such as retaining protection, scour protection and slope protection. Follow the "prevention first, combining prevention with control" concept, it adopted reasonable and comprehensive improvement plan and effective engineering measures. Besides, it combined with the method of laying pipeline, considered the terrain, geology, geomorphology, hydrology, water conservancy, weather and other conditions along the line, which are justified with related management regulations and flood control standard of the river and waterway. Stick to setting protection against damage, setting protection out of needs and seting protection according to local conditions.

3.1 retaining protection

The retaining wall is the most usual retaining protection. It is used to support landfill or hillsides to prevent landfill or soil deformation. It mainly bears the soil pressure. In the of civil engineering of highway, railway, water conservancy and mining departments, retaining protection is applied generally. in hydraulic protection project of long pipeline, as the main structure form of retaining protection, retaining walls can be used in the following situations:

- 1) protection for bottom slope against backfill erosion of slope trench.
- 2) while pipeline crossing the hillside, setting lateral retaining wall under shallow dredging and filling deep to reduce excavation volume and quarantee the thickness of cover

soil on the top pipe.

- 3) avoid collapse of crossing river bank by current scouring
- 4) avoid surface sliding and take measures for it.
- 5) restore landscape such as field ridge restoration

3.2 Scour protection

Scour protection of pipeline is mainly to protect the pipeline from long term or seasonal current scouring of the river and channel. Because current scouring action of river and chanel is devided into riverbed incision and river bank expansion, according to the fortification, the hydraulic protection measures against scouring are divided into bank and bottom protection.

The common revetment measures includes vegetation revetment, wood structure revetment, dry stone revetment, riprap, stone cage revetment, masonry slope revetment, masonry wall revetment and gabions jet flow dam belonging to the indirect river bank protection measures. Common bottom-protection measures includes: the dry stone over surface, masonry over surface, concrete flexible plate bottom protection, concrete pipe stabilization, anti scour wall masonry check dam, willow and stone check dam scour protection. In addition, it also involves other common hydraulic structures, such as canals (including masonry, dry masonry, concrete precast slab and soil The canal, etc.) and water tank. The selection of structure forms of torrent revetment is related to hydrological terrain conditions such as allowable velocity and the gradient.

3.3 slope protection

The slope protection of long pipeline mainly protect slope of pipeline security from rain scouring to prevent and delay the weathering, fragmentation and erosion of slope soil, and to maintain the overall stability of the slope.

To avoid trench backfill scoured by rain of steep slope, a diaphragm wall usually is built from the bottom and exposed some height in the trench every certain distance to avoid slope catchment corroding the pipeline.

In a certain extent, it can take into account both the slope beautification and coordination environment. Engineering protection mainly includes plaster, wall plastering, punching, shotcrete shotcrete mesh armor, armor, armor sack, anchor reinforced concrete cover, straw bag revetment, dry stone revetment, masonry revetment, masonry retaining wall, precast concrete block revetment, jointing and filling, cut-off wall and so on.

IV. OPTIMIZATION MEASURES

Although the traditional protective measures are immediately effctive, with the passage of time, there will be concrete rock weathering, aging, corrosion and so on. But ecological protection is just the opposite. The first effect is weak. With the growth of plants, It can more effectively curb soil erosion to ensure the pipeline stability. In addition, the vegetation can also restore the ecological ditch the which damaged by excavation. It is an optimization of the hydraulic protection measures combined with engineering measures and ecological protection.

The commonly used ecological protection such as seeding belt technology mainly adopts multifunctional filter blanket fiber technology whose porosity is as high as 70%~99.5%, formulation technology of green materials (including grasses, shrubs, cultivation materials, water retaining agent, karst agent and fertilizer), and use acupuncture method and spray

method to produce a variety of rubber the type of green vegetation. Advanced planting technology prevent soil erosion, which not only can prevent slope erosion and keep the slope stability, but also can replace expensive hard protective materials. It provides more choice for high slope treatment (slope of more than 30 degrees). Vegetation is divided into pre-soaking, laying, watering, and maintaining. Vegetation after completion.

V. CONCLUSION

The laying of pipeline in mountain area is complex. It is mainly divided into pipeline crossing river, pipeline along the river, pipeline along river bottom, pipeline across a slope, pipeline longitudinal slope and so on. Facing security risks of pipeline aerial bare and soil landslide. The hydraulic protection design for pipeline adopts cutting, row, block, prevention, guide etc. And using a combination of direct and indirect engineering project, combination of engineering measures and ecological measures to curb soil erosion and maintain the stability of pipeline.

REFERENCES

- [1]Guanghai Shi. Main Features of Topography [M]. The Annals of People's Republic of China. 2015
- [2]Yong Liu.Hydraulic Protection Design of Long Pipeline in Mountain Area [J]. Journal of Shengli Oilfield Staff University , 2008 (22) : 63-64
- [3]Bo Yu , Zhiming Wu. Practice of Hydraulic Protection In Pipeline Construction [J]. Oil - Gas Field Environment Protection , 2012 (22) : 64-67
- [4]E.N.Griskin.Analysis of the Performance of the Hydraulic Protection System of Electrodrills and Ways of Improving its Reliability[J] .in Chemical and Petroleum Engineering.1972
- [5]M. S. Trifel , Yu. Symposium on Corrosion Protection of Metal Elements of Hydraulic Structures and Pipes a Kochetkov in Hydrotechnical Construction[J].1971
- [6]Peimin Li. Hydraulic Protection Measures For Long Distance Gas Pipeline [J]. New Technology And Products Of China , 2009 (18) : 98-100
- [7] China Petroleum Planning And Engineering Institute [A]. General Report for Feasibility Study On China-Myanmar Gas Pipeline (Domestic)
- [8]Weigang Zhuang. Hydraulic Protection of Long Gas Pipeline in Shenzhen Mountainous Area [J].Shanghai Gas , 2010 (4) : 16-19
- [9]He Yao. Discussion on Several Problems of Soil And Water Conservation Construction Drawing Design for Long Distance Pipeline [J] 2013 (44) : 61-63
- [10]Yong Ma. Optimal Design of Hydraulic Protection for Long Distance Pipeline [J]. Technical Control , 2013 (5) : 245-246
- [11]Huifang Qi. Discussion on Design of Hydraulic Protection for Long Distance Oil-Gas Pipeline Project [J]. Shanxi Architecture , 2010 (36) : 360-362
- [12]Liang He. Hydraulic Protection And Soil And Water Conservation in the Second Section Xinjiang of West - East Gas Transmitting [J]. Yellow River , 2011 (33) : 82-83
- [13]Jian Mou. Hydraulic Protection of Gas Pipeline through Loess Area [J].Gas and Oil , 2006 (16) : 15-17
- [14]Botong Gu. A New Design Method of Hydraulic Protection for High Steep Slope Pipeline [J].Gas And Oil , 2006 (24) : 27-28
- [15]Yutao Deng. Hydraulic Protection in Long Distance Pipeline Engineering [J]. Oil-gasfield Surface Engineering , 2008 (27) : 70-72
- [16]Jianfeng Chen. The Application of the Vegetation Belt Technology in Hydraulic Protection Project [J]. Petroleum Engineering Construction , 2005 (31) : 75-77

ZHAN tingwen

Master, Southwest Petroleum University, Chengdu Sichuan, 610500

CHEN liqiong

Professor, Southwest Petroleum University, Southwest Petroleum University, Chengdu Sichuan, 610500

TANG fan

Engineer, Sichuan Ding Neng investigation and design of Oil and Gas company, 610000

SUN jingyun

Master, Southwest Petroleum University, Chengdu Sichuan, 610500

SHI yazhou

Master, Southwest Petroleum University, Chengdu Sichuan, 610500

*This article is supported by national 13th five-year key projects (2016YFC0802100) Evaluation of storage and transportation facilities and security technology of long distance oil-gas pipeline and China Engineering Academy searching project (2015-XZ-37) Security development strategy research for oil-gas pipeline net system.