Libyan Journal of Science & Technology 13:2 (2021) 82-84

Faculty of Science - University of Benghazi

Libyan Journal of Science & Technology

journal home page: www.sc.uob.edu.ly/pages/page/77

Study of the mechanical properties of pipes used in irrigation networks in the Libyan market.

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Highlights

- **Thermoplastic pipes HDPE have had widespread application in water conveyance.**
- **It is very noteworthy to study the mechanical properties of HDPE pipes.**
- **The mechanical properties of some HDPE pipes materials used in irrigation networks in the Libyan market have examined**

ARTICLE INFO

Article history:

Received 02 December 2019
Revised 15 July 2021
Accepted 17 July 2021

Keywords:

Hardness, irrigation, mechanical properties, pipes.

ABSTRACT

The variety in types and grades of Irrigation pipes make industry standards is more significant. These standards serve to identify each kind of Irrigation pipe, dimensions, workmanship, sustained, and pressure. The present work thus aims to study the mechanical properties of three types of pipes, which are used in irrigation networks (in the domestic Libyan market). The tensile strength, impact, and hardness tests were investigated. Based on the results obtained, the highest value for the hardness test was recorded by pipes manufactured in Libya (from pure raw material S1) 609. Meanwhile, the other pipes (S2, S3) registered 541 and 508 respectively. Pipes (S3) proved to be better in the impact test where it recorded 63.7KJ/m^2.In contrast, the pipes (S1) showed 33.3 KJ/m^2 and as expected, the recycled pipes (S2) have revealed the lowest value for the impact test 13.27KJ/m^2.

1-Introduction

The properties of numerous polymers are considerably influenced by means of exposure to indoor or outside weathering (Qayyum, 1986). In countless programs, in particular, irrigation networks PE pipes are subjected to outside weathering conditions. So it is far very noteworthy to study the modifications of the engineering properties of PE pipes material as a result of the effect of outdoor weathering conditions. A study turned into assumed to quantify the consequences of UV radiation on the properties of PVC pipes (PVC Pipe Association1986). The results done confirmed that the publicity to UV radiation led to trade in decreasing impact strength and pipes' surface color.

In contrast, the other properties, for example, pipe stiffness and tensile strength are not adversely affected. The effectiveness of outdoor weathering conditions on the fracture toughness of PVC pipes was also studied (Ollick and Al-Amri, 2000). The results obtained from the study revealed that the fracture toughness has decreased by 50%, which is caused by exposure to outdoor weathering conditions. In addition, the behavior of material converted and became additional brittle. The impact test for pipes of outside weathering at the residual stresses and mechanical properties in injection molded (semi-crystalline) polymers was investigated too (Choi *et al.*, 1998). (Polypropylene (PP), Nylon 6.6 (N6.6) and Poly(oxymethylene) (POM) were used. The test samples were exposed to outdoor weathering conditions for periods of time, which reached up to three years.

The experiment results presented that, the exposure to weathering conditions shaped tensile residual stresses near the surfaces of the polymers mentioned. Regarding N6.6, the yield declined for 1.5 years when the exposure to outdoor weathering decreasing by 35% while the higher yield stress for both PP and POM remained almost constant after the period of time. Moreover, for the outdoor weathered PP and N6.6 samples, the elongation at break continued roughly at the same value through the first year and it decreased affectedly to ten percentage of its first value through the second year while it reduced about 10% for POM. All specimens weathered in the shade, the elongation to break decreased about 35% for both N6.6 and PP while stayed constant for POM. A study conducted in Pert, West of Australia for effeteness of the weathering on fracture toughness and yield strength of unreinforced and short glass-fiber reinforced thermoplastic polyester was examined by using CT test samples naturally weathered for 11 months outdoors (Breen, 1995).

The weathering induced a percentage has dropped to 15-35% in the fracture toughness. The yield strain of unreinforced polyester has raised to around nine percent at the same time as it declined with the aid of 11% for brief glass-fiber reinforced polyester. Moreover, the elongation test to break the weathered for all specimens decreased. The fracture toughness of PVC and PVCCPE were affected by the environment and studied too (Tong and White, 1997). The results acquired from this study confirmed that the environment has affected the fracture longevity and crack growth for each PVC and PVCCPE even as the crack growth and fracture longevity resistance decreased within the presence of benzene steam. Researchers have been established that some fillers such as clay, calcium carbonate, and kenaf powder could be added to recycled high and low-density polyethylene (HDPE/LDPE) in an attempt to improve their mechanical properties. A study conducted compared the mechanical properties between virgin polyvinyl chloride

 ISSN: Online 2663-1407, Print 2663-1393; National Library of Libya, Legal number: 390/2018

(vPVC) and recycled polyvinyl chloride (rPVC) filled with two different natural fibers (palm fibers and sawdust) and got good results (Elhrari *et al*., 2019).

On the other hand, the effect of increasing filler content decreases the tensile strength of recycled polyethylene, which might be attributed to the inability of the fillers to support stresses transferred from polymer virgin. The addition of a filler phase to the matrix body during the composite preparation might improve the mechanical characteristics of composites (Ashik and Sharma, 2015). The incorporation of filler in the composite is trying to improve tribological and mechanical properties. In addition, the mechanical properties of glass, sisal, and jute filler reinforced polyester composites were also studied (Ramesh *et al*., 2013). The addition of glass fiber into jute fiber composite resulted in maximum tensile strength; jute and sisal mixture composites samples are able of achieved supreme impact strength and having maximum flexural strength for the sisal filler composite. Similarly, (Zamri *et al*., 2012) studied conducted showed the mechanical properties of glass/jute reinforced polyester with water absorption conditions and concluded that it is not appropriate for underwater applications.

A cement kiln dust (CKD) is used as filler in High-Density Polyethylene (HDPE) polymer to provide some improvement in the polymer properties as well as reducing the cost of production (Elhrari *et al*., 2018). Pipes manufactured from Low-Density Polyethylene (LDPE) are extra flexible than those, which are, made from High-Density Polyethylene (HDPE), therefore, HDPE pipes are used as main lines while LDPE pipes are used in irrigation networks as sub-lines. The main goal of this research is to examine the mechanical properties of some HDPE pipe materials when used in irrigation networks in the Libyan market.

2. Experimental

2.1. Materials and Methods

Three different Polyethylene pipes were collected from local markets (pure raw material S1 and recycled materials were manufactured in Libya, S2 and pipes imported from Italy S3) and washed by water to remove any impurities then dried in sunlight in an open place to lower the moisture level. Consequently, chopped into small length segments, and further cut into pieces ranging in size from approximately 0.5–4.0 mm in a shredder machine.

3. Results and Discussion

3.1 Hardness

Five test pieces were used for each type and their average value was determined as shown in Table 3.1, which was determined by using a Shore D durometer (RayRan) in accordance with ISO 868:2003. The test procedure and sample preparation are usually simple, and the results might be used in estimating another mechanical property. Hardness testing is widely used for control and inspection (Ashik and Sharma, 2015). There is an important difference in the hardness properties for the three types of pipes. The recycled pipes registered the lowest value, which contributed to the addition of many types of polymers to HDPE.

Table 3.1

Hardness value for pipes

Sample No.	S1	S2	S3
1	610	545	510
2	610	530	500
3	620	540	500
4	615	540	510
5	590	550	520
average	609	541	508

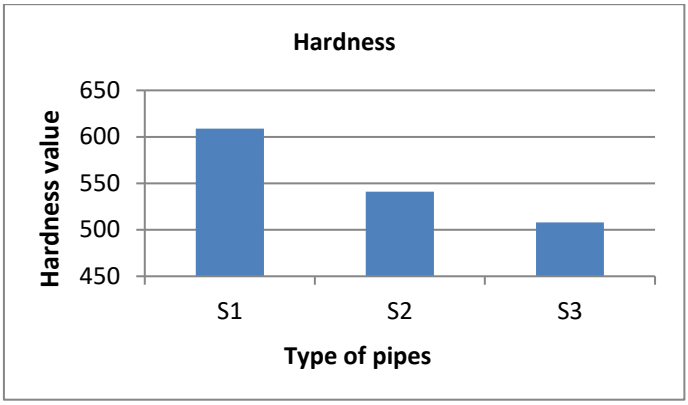

Fig 3.1. Comparison between hardness values for each pipe

3.2 Impact test

The measured Impact test values of all three samples are presented in Fig. 3.2. and Table 3.2 using the CEAST Resil Impactor tester, with an impact energy of 15 J. It can be viewed that the impact value of S3 is higher than compared to S1 and S2. This is considered the most important test for pipes. The impact test for S3 registered 63.72 KJ/m^2, which was considered doubled of S1. Among three types of samples, pipes manufactured in Libya from many materials showing less impact value. This may contribute to some impurities in the composition of S2

Table 3.2

Impact test

Sample No	S1	S2	S3
1	66.975	11.825	67.7
2	25.525	11.625	92.975
3	25.1	12.825	74.1
4	26.475	11.975	44.975
5	22.475	17.925	38.850
average	33.31 kJ/m^2	13.235 kJ/m^2	63.72 kJ/m^2

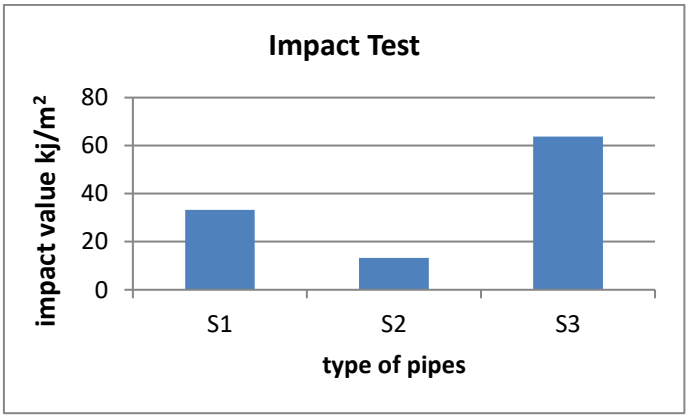

Fig 3.2. Comparison between impact values for each pipe

3.3 Tensile strength

The tensile test is the test in which an increased load is placed on the pre-prepared sample according to certain standard specifications, by holding both ends with special equipment and placing the load centrally and visually And the sample length increases as a result of this tensile or drag. The test results for tensile strengths are shown in Fig. 3.3 by using the Universal Tensile testing machine Prodit 3kN. At least four samples for each type were taken and the average value was estimated. It can be observed from Fig. 2.6 that the tensile strength of S1 is more as compared to S2 and S3. This might due to the fact that the good quality of the raw material. Among three types of pipes, the imported pipes (S3) which are imported as mentioned before showing less tensile strength value,

and this needs more accurate examines from the quality control department epically in Libyan ports.

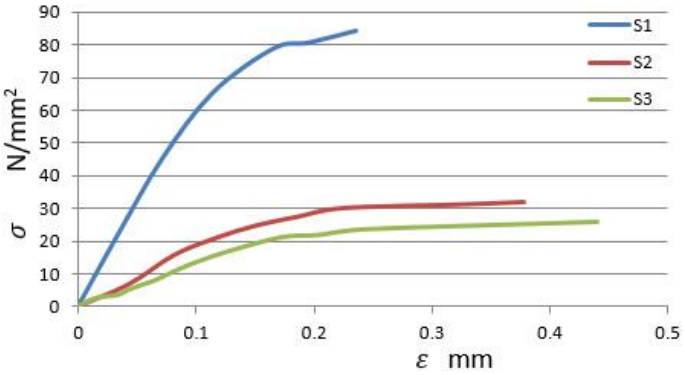

Fig 3.3. Comparison tensile testing between (S1, S2, S3)

4. Conclusion

Global investments in infrastructure are expected to grow especially in developing countries such as Libya. Everywhere, consumers are seeking sustainable products, which ensure their health and safety; and specifiers want high-performance, reliable solutions with a low total cost and extended lifetimes. The sustainability of pipe networks needs to be improved. This study examined the comparing of the mechanical properties of three pipes, which are used in irrigation networks in the Libyan market. It was pointed out that there was a considerable difference in impact and hardness test between the samples.

Acknowledgment

The author is thankful to the staff of Polymer Research Centre-Tripoli for their support in this research.

References

Ashik, K.P., and Sharma, R.S. (2015) 'A review on mechanical properties of natural fiber reinforced hybrid polymer composites', *Journal of Minerals and Materials Characterization and Engineering*, 3, pp. 420-426.

Breen, J. (1995) 'Environmental stress cracking of PVC and PVC-CPE ', *J. Mater. Sci.*', 30, pp. 5833-5840

Choi, N.S., Takahashi, K., Oschmann, D., Kargerkocsis, J., and Friedrich, K. (1998) "Influence of weathering on unreinforced and short glass fiber reinforced thermoplastic polyester", *J. Mater. Sci*., 33, pp. 2529-2535

Elhrari, W., Salah, M.A., Abdulbaset M A-Q, Abdalah, k. (2018) 'Mechanical Properties of High-Density Polyethylene/Cement Kiln Dust Composite', *Res Dev Material Sci*, 8(1). RDMS.000677.

Ollick, A. and Al-Amri, A.M. (2000) "The effect of outdoor weathering conditions on the fracture toughness of PVC pipes", *Alexandria Engineering Journal*, 39, 6, pp. 837-846.

Qayyum, M.M. and White, J.R. (1986) 'The effect of weathering on residual stresses and mechanical properties in injection-molded semi-crystalline polymers', *J. Mater. Sci*., 2, 2391-2401.

Ramesh, M., Palanikumar, K., and Reddy, K.H. (2013) 'Mechanical property evaluation of Sisal-Jute-Glass fiber reinforced polyester composites', *Composites*: Part B, 48, pp. 1-9.

Shebani, A., Algoul, S., Al-qish, A., Elhrari, W. (2019) 'Impact Strength and Surface Hardness Properties: Virgin PVC Versus Recycled PVC Composites Filled with two Different Natural Fibers', 2nd Conference for Engineering And Technology Science October, 29-31, Sabratha-Libya**.**

The uni-Bell PVC Pipe Association(1986), "The effect of UV aging on PVC pipe", Uni-Bell's UNI-TR-5 2655 villa Creek Drive, Suite 155, Dallas, Texas 75234

Tong, L., and White, J.R. (1997) 'Residual stress distribution modification caused by weathering in polypropylene and polystyrene', *Polymer Engineering and Science*, 37, 32, pp. 321-328.

Zamri, M.H., Akil, H.M., Bakar, A.A., Ishak, Z.A.M. and Cheng, L.W. (2012) 'Effect of water absorption on pultruded Jute/Glass fiber-reinforced unsaturated polyester hybrid composites, Journal of Composite Materials, 46, pp. 51-61.