ABSTRACT

This paper aims to propose an interactive tutoring environment, using humanoid robots, to support children with autism disorders. Statistics indicate an increase in the use of robotics (more than 5000 robots) in more than 50 countries for teaching and learning purposes. Therefore, the process of choosing the modern teaching method that appropriates to the level of the student is a crucial matter. The proposed interactive teaching framework consists of three phases, including preparing the suitable class materials, programming the NAO robot, and evaluating the performance of the teaching methods on students' communication and academic skills. Besides, it implements a multiple-scenario approach to developing lesson plans and verifying student acknowledgments to lessons and updating the curriculum as necessary. The robot is used as an assistant tool to help students read stories, spell words, and correct students' answers to a particular Math question. The results show that the use of robots as tutors help students learn difficult topics with their native language easily and enjoy educational gaming activities. It also helped teachers to create new lessons by browsing online teaching resources and adding them to the lesson plan based on the course profile schedule and students' feedback. Also, the participants indicated that using a tutor robot is offering no bias against students' gender, race, socioeconomic status, personal preference, or other considerations.

Keywords:
Robot Tutor, NAO robot, Teaching Methods, children with Autism.

1. INTRODUCTION

Due to recent developments in artificial intelligence and robotic technology, robotics has become one of the most promising fields in the current decade [1]. The use of robots to assist teaching and learning on different levels has become an extensive research field. Also, the latest statistics show the total sales of professional service robots in 2017 increased by 85% (to 109,543 units) compared with 59,269 units in 2016. This is an increase of 39%, reaching 6.6 billion US dollars [2] as shown in Figure 1.

Many research papers explored and reviewed the implementation of robots for many fields, including healthcare [3-5], industrial [6-7], and education [8-12]. Chang [8] explored the previous studies regarding the use of educational robots and analyzed the features of robots and instructional media. Alemi M. et al. [9] examined the impact of utilizing a humanoid robot as a tutor in teaching a foreign language for children. The research shows that there was an increase in students’ performance. Fernández-Llamas et al. [10] investigated the impact of employing a social robot as a teacher in teaching and compared it to a human teacher. The research explains that there is no significant difference in performance between the two teaching methods. Jabar et al., [11] developed a questionnaire to determine the satisfaction rate of using a humanoid robot in teaching and learning. The result shows that 71% of the participants agreed and believed in using humanoid robots in teaching and learning. Cheng, Y.W et al. [12] deployed a literature review for determining the fundamental applications of educational robots. The results have proven that robotics, linguistics, social, and education are the top applications. Also, the use of robotics in teaching Pre-and primary schools was the most likely to adopt educational robots in the future.

![Figure 1: Sales value of service robots in the World](image-url)
motivate students to learn. The robot also supports the development of learning skills, communication, and collaboration between students to perform assignments and joint projects [13]. Use of robots in education is a promising research field because of many factors that need to be addressed and investigated. Therefore, this paper aims to suggest a teaching framework based on robots as a potential tutor to assist in teaching Autistic children at different levels.

2. SOCIAL ROBOTS & AUTISTIC CHILDREN

Social robots can communicate and act with people by simulating human social behaviors such as speech, hearing, sight, movement, and response to commands dynamically and vocally. A humanoid robot is a type of social robot with different shape and size that interface and interacts with people on a day to day basis and could play an essential role in human society in the future. Human-robot interaction (HRI) specifies a communication relationship between human and humanoid robots. The new development in HRI has extended its functions to assist the children suffering from Autism Spectrum Disorders (ASD). These functions incorporate many areas like socialization, communication, and social behavior through robot-based mediation [14]. According to new records of the "World Health Organization", almost 1 in 160 children are classified with ASD symptoms [15]. The previous research clarified that HRI is a particular focus for teaching and training children with ASD.

3. LITERATURE SURVEY

Many researchers discussed and proposed solutions for teaching and educating children with Autism based on different methods. Spolaôr, N. et al. [16] implemented a mobile robot based on an experimental study. The results show that half of the participants indicated that the robot improves autistic children's social skills. Dautenhahn, K et al. [17] used a Humanoid robot called “Doll” based on conversation analysis (CA) in England. The findings of this research show that the use of “Doll” enhances the attention of Autistic children. Robins, B. et al. [18] implemented different robot toys as Assistive Technology (AT) to increase or improve the capabilities of children with special needs. The results show that children like to interact more with a plain and featureless robot over human-robot.

Kozima, H. et al. [20] develop an experimental study using the human arm and a robot arm to help children do their assessments. Assistive Technology (AT) is aimed to examine the possibility of implementing the robots in the learning process. The results show that the robot helps children to move and act faster. De Silva et al. [24] used social assistive robotics therapy systems to help children with Autism Spectrum Disorder. The experimental study was implemented in Australia and the results show that the robot was socially assistive in a therapeutic setting for children with ASD. Feil-Seifer, D. et al. [31] used the NAO robot as an experimental study in Malaysia. The study proposed guidelines, rules and procedures to serve as therapy for children with Autism.

Dickstein-Fischer et al. [34] deploy an experimental study based on the KASPAR robot in UAS. The results show that the robot helps children with Autism to increase body awareness, self-sense, and collaborative play. Jeff Goodman [38] reviewed and analyzed the use of different social and humanoid robots such as NAO, KASPAR, Robota, and Probo to teach autistic children. The results indicate that the robots enhance the social interactions and communication skills of ASD children. There is a need for implementing and deploying new information technologies and tools to enhance the teaching and learning methods [40]. Table 1 presents the full review of the literature of different approaches to teaching children with Autism based robot.

4. RESEARCH METHODOLOGY

In this study, we designed and developed an experimental framework based on NAO robots for teaching and educating children. A quantitative and qualitative research methods were utilized to achieve the objectives of this research and to solve the issues identified in the review of literature based on the critical analysis of previous studies. The data collation gathering base on a personal interview. The proposed framework implements a multiple-scenario approach to developing lesson plans. This is in addition to monitoring and verifying student acknowledgments to lessons and updating the curriculum as necessary, as shown in Figure 2.

5. PROPOSED FRAMEWORK DEMONSTRATION

This paper is comprised of both theoretical and practical parts of using the robot in teaching and educating. It proposed an interactive teaching framework based on the interaction between the three system actors (Tutor, Robot, and Student), as shown in Figure 3.

Figure 3. Actors interaction in the proposed teaching framework

The tutor implements several teaching lessons on the NAO robot, and the student can hear and interact with robots using voice, touch, and movement. Then, the robot interprets the student inquiry and acts accordingly, as shown in Figure 4. In this
A Math lesson sample of the proposed teaching framework

The curriculum update is done based on the feedback that the tutor gets from the students. Besides, there are several practice tests that were designed to assess student performance and knowledge [41]. The results of the experiment will be used as a backward feeding data to update the curriculum and improve the lessons.

A Story lesson sample of the proposed teaching framework

6. PROPOSED FRAMEWORK DEMONSTRATION

This paper aims to discuss the importance of robotics in education and its impact on the students’ social and educational skills. Educational robotics provide ideal platforms for all students to be introduced to topics related to science, technology, engineering, mathematics, physics, and programming. The literature review of existing research studies and the results of practical tests clearly show that robot based teaching improves children's communication skills and ability to read stories.

Robots also enhance problem-solving techniques and promote active learning, which can be adapted to existing school programs and quickly enhance and update the class materials. More work still needs to be done to determine the proper teaching methods and materials. The relationship between the direct (teaching and assessment method) and indirect factors (socio-economic, financial support) that affect the students' performance also needs to be addressed. Another direction for future work is to apply low price robots for low-income countries.

However, a valid questionnaire should be designed and developed to answer the research questions such as:
- How impactful is the implementation of artificial robots in education?
- How does teaching based on artificial robots correlate with student performance?
- How does teaching based on artificial robots correlate with student engagement?

The future work is to add more teaching lessons and to use flipped classes to increase the student-centered methods. More interactive lessons that ensure to engage the student in discussion topics between the robot and the student should also be designed.

REFERENCE:


Table 1 survey of research papers on the using robot method

<table>
<thead>
<tr>
<th>Ref. No/ Year</th>
<th>Robot Name</th>
<th>Method</th>
<th>Location</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>[16]/2004</td>
<td>Mobile robots</td>
<td>Experimental Study based robotic and software.</td>
<td>Switzerland</td>
<td>Half of the participants indicate that the robot improves the social skills of Autistic children.</td>
</tr>
<tr>
<td>[18]/2006</td>
<td>different robot toys</td>
<td>Assistive Technology (AT)</td>
<td>England</td>
<td>Children like to deal more with a plain and featureless robot over human-robot.</td>
</tr>
<tr>
<td>[19]/2007</td>
<td>Keepon robot</td>
<td>Qualitative and quantitative analysis.</td>
<td>Japan</td>
<td>The robot Keepon improves social skills and feel.</td>
</tr>
<tr>
<td>[20]/2008</td>
<td>Human or a robot arm model</td>
<td>Assistive Technology (AT)</td>
<td>Italy</td>
<td>The robot helps children to move and act faster.</td>
</tr>
<tr>
<td>[21]/2008</td>
<td>AIBO Dog robot (Kasha)</td>
<td>Comparison Study (CA)</td>
<td>USA</td>
<td>AIBO robot enhances children's spoken abilities and engagement.</td>
</tr>
<tr>
<td>[22]/2008</td>
<td>Mobile robot (Tito)</td>
<td>Experimental Study based mobile robot and human being.</td>
<td>Canada</td>
<td>Tito enhances children's skills like visual contact and physical proximity more than a human tutor.</td>
</tr>
<tr>
<td>[23]/2009</td>
<td>Therapeutic-assisted robot</td>
<td>Mixture Gaussian-based cluster method.</td>
<td>Japan</td>
<td>Results show that the robot helps to build engagement between children and robots as mediators.</td>
</tr>
<tr>
<td>[24]/2009</td>
<td>Social Assisitive Robotics</td>
<td>Experimental Study of ASD therapy-based robot systems.</td>
<td>Australia</td>
<td>The robot socially assistive in a therapeutic setting for children with ASD.</td>
</tr>
<tr>
<td>[25]/2009</td>
<td>Mobile robot</td>
<td>Conversation Analysis (CA)</td>
<td>England</td>
<td>The robot analyses the boys talking and extract the monotonous speech.</td>
</tr>
<tr>
<td>[26]/2009</td>
<td>Zoomorphic robot</td>
<td>Experimental Study based mechanical dog robot.</td>
<td>USA</td>
<td>The results show that the robot enhances social skills.</td>
</tr>
<tr>
<td>[27]/2009</td>
<td>Modular robotic tiles</td>
<td>Experimental Study based mechanical tiles and Neural system modules.</td>
<td>Spain</td>
<td>The results showed improved social interaction effects in individuals mimicking autistic children with 88% exactness.</td>
</tr>
<tr>
<td>[28]/2010</td>
<td>LEGO robot</td>
<td>Experimental Study based robot with Four scenarios.</td>
<td>England</td>
<td>Enhance the association with robots and improve the social communication of youths with both autism and mental impairment.</td>
</tr>
<tr>
<td>[29]/2010</td>
<td>LEGO robot</td>
<td>Experimental Study of mechanical technology class based robot.</td>
<td>USA</td>
<td>The results show an increase in social interactions.</td>
</tr>
<tr>
<td>Year</td>
<td>Project Name</td>
<td>Study Type</td>
<td>Location</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------</td>
<td>---------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2011</td>
<td>Social Assistive Robot</td>
<td>Experimental Study</td>
<td>Spain</td>
<td>The robot measures the positive, and negative feedback depends on the behavior of the participant. The robot increases the social behavior of children.</td>
</tr>
<tr>
<td>2012</td>
<td>NAO robot</td>
<td>Experimental Study</td>
<td>Malaysia</td>
<td>They are proposing guidelines, rules, and procedures to serve as therapy for children with autism.</td>
</tr>
<tr>
<td>2012</td>
<td>Mobile robot</td>
<td>Experimental Study</td>
<td>France</td>
<td>Used a robot-child as a mediator to express positive emotion in the therapist session.</td>
</tr>
<tr>
<td>2014</td>
<td>penguin PABI robot</td>
<td>Experimental Study</td>
<td>USA</td>
<td>The children are engaged and communicated more with the humanoid robot.</td>
</tr>
<tr>
<td>2015</td>
<td>KASPAR humanoid-robot</td>
<td>Experimental Study</td>
<td>USA</td>
<td>The robot helps children with autism to increase body awareness, self-sense, and collaborative play.</td>
</tr>
<tr>
<td>2016</td>
<td>KASPAR robot</td>
<td>Experimental Study</td>
<td>USA</td>
<td>The Robot helped children to recognize and convey their feelings and apply calming abilities and meaningful discussion.</td>
</tr>
<tr>
<td>2016</td>
<td>Pepper Robot</td>
<td>Experimental Study</td>
<td>USA</td>
<td>The robot helped autistic children to enhance the concept of emotions and learning.</td>
</tr>
<tr>
<td>2017</td>
<td>MILO robot</td>
<td>Experimental Study</td>
<td>USA</td>
<td>The results show that autistic children are more engaged with the Milo robot than with a physician therapist.</td>
</tr>
<tr>
<td>2017</td>
<td>NAO, KASPAR, Robota, Probo</td>
<td>Review Study</td>
<td>USA</td>
<td>The results show that the robots enhance the social interactions and communication skills of ASD children.</td>
</tr>
</tbody>
</table>

**Figure 2. The propose interactive teaching framework**
Mechanical Properties of Concrete exposed to oil products

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Abstract- There is no doubt that oil products have a clear effect on all materials, especially building materials, including concrete, so we must strive to improve the properties of chemical resistance and mechanical resistance in order to reduce the impact of oil, making it serviceable.

Where it was studied how to reinforce concrete with wood ash associated with waste coming out from the towers of power plants and at specific rates that do not exceed 3%, making it more resistant than reference concrete as shown by the results when measuring compressive strength and tensile split resistance. The negative effects of regular oil products in concrete were that the addition of ash reduced these effects. In different oil products and outdoor the higher value of compressive strength in outdoor with wood ash 23 MPa, splitting tensile strength test value is 5.8Mpa where the negative effect of oil products (various kinds) emerged as it was the deadliest effect of casawil.

Index Terms—

I. INTRODUCTION:

Research has demonstrated that high dose levels of fly ash can be used in construction applications to produce concrete with good mechanical properties and high durability. Thus, the use of ash should allow burning wood to make concrete with operational ductility because fly ash has high surface tensile properties that change the bonding between cement and water particles with high ash particles and as compared to less compared to Portland cement concrete of the same workability.

Building materials have the ability to work with new applications, including concrete, and design and construction techniques have also contributed to their development. The comprehensive diversity of economic requirements which contribute to meeting a wide range of needs make it a very competitive building material. The increasing application requirements for structures and the ability to withstand harmful elements required the development of new reinforcing materials and concrete composites to meet high performance and durability standards. Environmental factors and the accumulation of waste from the industry have made great [1].

Ref. [2] made a survey about wood ash used in concrete and its effect on Mechanical properties of cement concrete with the use of Cement with Prosopis multiflora (PJA) as an alternative to cement when mixed with different proportions, where the operational properties of cement mixed with water were evaluated in the form of non-solid concrete for mixtures with the help of the slack cone test and the mechanical properties such as compressive strength, shock resistance and bending properties of reinforced concrete beams were evaluated. Which made it a study that included concrete in all its state.

Ref. [3] implemented a plan aiming at predicting the effects of kaolin (K) and calcined kaolin (CK) to use these materials as a substitute for cement in different proportions and the extent of their impact on the mechanical properties and durability of the bonding materials under different conditions and in room conditions. Where the process was carried out in different proportions, and a measurement of the strength properties was made using the compressive strength test, and where the results were promising improvement in the mechanical properties in general.

Ref. [4] used Chemosphere as a leftover industrial waste that has been used as a substitute for crushed gravel, but is lightweight in concrete structures. In this work, the effect of this material on the mechanical properties and its actual applicability to practical application in the field of work was studied. This was done by measuring the compressive
and bending strength, and various mechanical properties. It also studied the ability to push the course of work from an environmental and economic point of view, due to its effective role in the disposal of waste and the optimal employment in a way that guarantees a cleaner environment.

Ref. [5] The researchers worked to improve the mechanical properties of the cement-reinforced lime materials, and the results presented were analyzed after the examination, where the experiments carried out by the working group showed that high pressure changes the local mechanical properties of chalk as a cheap and alternative material for cement, which leads to a significant weakening of the strength properties (tensile stress, mono. Axial / Triaxial and Pore Collapse Stress) on areas approaching the high pressure impact. The use of acidic media has a greater effect on the lime material associated with the cement.

Ref. [6] One of the most dangerous cases of fly ash disposal (FA) from coal-fired power plants and the peel extracted from the use of oil palm fruits is of serious environmental impact. Also, the disadvantages resulting from extracting river sand and granite from the green hills in a way that is not permissible or not according to certain specifications to be used in the manufacture of used concrete, which is working on a large scale at the present time, which makes researchers resort to alternative solutions, which leads us to use the oil palm crust (OPS). Fly ash as an ingredient for mixing in concrete production of lightweight aggregate free of granite is a fitting idea as this ash has good workability with cement.

Ref. [7] studied the possibility of using fibers as a reinforcing material for concrete, which is not new, as this engineering theory changed the cost of producing concrete and the ability to improve mechanical properties, especially in tensile situations, i.e. applications in which concrete sections bear high tensile loads, as it gave the concrete section more ductility and relative bearing greater than Portability of traditional concrete materials In this work PVA fibers and basalt fibers were used as hybrids in order to reduce production costs as they saved. The paper aims to study effect the environmental conditions on concrete and concrete, supported by coal ash, where mechanical properties are studied in the case of the mentioned ratios. The environmental conditions and exposure to oil solutions are examined as mechanical resistors efficiency.

Ref[8] The current work deals with a study of the ability of reinforcement with rods and how the reinforcement affects the internal structure of normal concrete, as the evidence for the internal change was the results of the tests for the compression resistance test, which were conducted on two groups in which the mixing ratios of concrete changed in general, which were supported by different proportions of the rods. The ages of the models ranged. From 3 days to 28 days, . It was found that the rebar altered the concrete pore structure. In terms of size, the pore structure of concrete increases with the increase in the cementation ratio. At the same age, the compressive strength of concrete in reinforced concrete .It was more than the force applied to the reference concrete because this internal structure has an effect on the compressive strength test results.

Ref[9]Previously, delving into the tensile strength of concrete was an unquestionable topic, as concrete is classified as a solid, but brittle building material. However, the process of reinforcement with reinforcing rods changed the concept of popularity, which made concrete feel susceptible to tensile loads as is the case with compressive loads. Separate tensile test is a method frequently used to determine the tensile strength of concrete. Such a test is subject to many factors, including size and accompanying conditions. Because it is impossible to determine the tensile strength of fiber reinforced concrete (FRC) using the standard tensile test method. So the tensile test would be another way, which is the slip tension, the modified tensile division test. Cleavage tests were performed on standard cylindrical samples as per internationally agreed specifications. Where the tests recorded satisfactory results according to the nature of the concrete and the type of reinforcement.

II. EXPERIMENTAL

For preparing the PCC specimens, using portland cement (type I), AL- Ekhaider sand (4.75mm maximum size) as a fine aggregate and bigger size aggregate crushed 37.5 mm maximum, as well as wood ash was add as a part of cement weight. Two mixes design were used in this work:

**Group 1**: – (1: 1: 2) 100*100*100 cubic specimens including plain, and wood ash concretes. Cement content was 9 kg/m³ and the w/c ratio was 0.5 for each mixture. The content of additives materials was 0.15% from the cement content by weight.

**Group 2**: – (1: 1: 2) 100*200 cylinder specimens including plain and wood ash concretes. Cement content was 11.5 kg/m³ and the w/c ratio was 0.5 for each mixture. The content of additives materials was 0.15% of the cement content by weight.

**Test Procedures**

Compressive strength test

The method of checking the compressive strength of ordinary concrete and concrete reinforced with wood ash is carried out by means of a hydraulic compression device, illustrated in Figure 1, where a prefabricated concrete landfill, which was submerged in water for a period of 28 days, is then submerged in different petroleum products mediums (gasoline, kerosene and kerosene) and in the air, where certain loads are shed until the collapse of the concrete model, the compressive strength is calculated by measuring the force that caused the failure of the model B kilo newton and calculating the cross-sectional area of the model to be examined through Equation No. 1.
**Compression** = force / area ……(1)

Compression: [MPa].
Force: [N].
Area: [m²].

**Splitting tensile strength:**

Measuring the slip tensile strength of regular concrete and reinforced with wood ash is done by using the same compression device, but the manufactured cylindrical models are placed horizontally where a plastic plate is placed above and below the cylindrical model and the load is placed on it until failure as shown in Figure 2 and the slip tensile strength is calculated through the equation Number 2

\[ T = \frac{2P}{\pi DL} \]  

Where: \( T \): splitting tensile strength, (MPa).  
\( P \): Maximum applied load, (N).  
\( D \): diameter of specimens, (mm).  
\( L \): length of the specimens, (mm).

**TABLE 1:** CUBIC SPECIMENS’ MIXTURE INVESTIGATION

<table>
<thead>
<tr>
<th>Mixed component by weight</th>
<th>Plain concrete</th>
<th>Wood ash concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement gm/cm³</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Water lit.</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Fine aggregate Gm/cm³</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Wood ash gm/cm³</td>
<td>0</td>
<td>1.65</td>
</tr>
</tbody>
</table>

**III. RESULTS AND DISCUSSIONS**

Compressive strength test results:

Figures (1) and (2) summarize the results of the compressive strength values of ordinary sample and concrete reinforced with wood ash, as it was submerged for different periods of time in oil products compared to reference concrete that was left in the air, where it was submerged with water after removing the molds and then treated with air until the age of The test, over time (reference concrete) showed a continuous increase in strength The development in the compressive strength values of concrete is explained by the fact that it is the strong bonding between cement atoms with water, which forms new structures resulting from the bonding of hydrogen atoms with the cement atoms, and the chemical bonding obtained is a heat emitter, which indicates the success of this type of bonding and the aggregates [12].

Test results of concrete samples immersed in petroleum products showed a continuous decrease in compressive strength with increasing immersion time. This decrease in compressive strength may be due to stretching of the gel into the pores and diffusion of solid moisturizing components due to the penetration of oil products into the microstructure of the concrete resulting in weak adhesion and cohesion forces in the cement in addition to the effects of oil products on concrete surface reactions, which have been confirmed by investigations Others [13].

Whereas for wood ash samples, the reason for the lower compressive strength may be due to the lower adhesion forces between the cement paste and the aggregates and also due to the insulation where a layer of wood ash forms as a result of the absorption of a portion of water added to the concrete [14].

Figure 3 describes the fracture mode when regular concrete is more robust than concrete with the addition of wood ash appears in the benzene effect that occurred due to the effect of the hydrogen group on the water cement and how the bonds between the cement composition could be dissolved.
increase in the ratio of aggregate to cement. As the results indicated for concrete samples exposed to oil products for a period of 28 days increased slightly compared to the reference sample (which was left in the air in the same period) due to the fact that the pores inside the concrete were still partially filled with water leads to more wetting, which reduces the chemical failure of the expected decomposition of the concrete. Inside oil products and the split tensile strength increases [16].

After 28 days of exposure period, the tensile strength of the concrete decreases with increasing exposure time for petroleum products. This reduction is due to chemical reactions between the different oil products and moisturizing products that involve the formation of expanded products that result in a loss of a certain tensile strength [17],[18]. Whereas, the decrease in wood ash may be due to the expansion of the voids formed due to the absorption of water by the wood ash. And through the results that emerged, the magnitude of the decrease in the tensile strength values is clearly visible with the increase in the ratio of aggregate to cement. [19]

As the results indicated for concrete samples exposed to oil products for a period of 28 days increased slightly compared to the reference sample (which was left in the air in the same period) due to the fact that the pores inside the concrete were still partially filled with water leads to more wetting, which reduces the chemical failure of the expected decomposition of the concrete. Inside oil products and the split tensile we notice an improvement in the compressive and slip tensile strength for reinforced concrete with wood ash even in small proportions, as this work agreed with the ref][20][21].

Test results of concrete samples immersed in petroleum products showed a continuous decrease in compressive strength with increasing immersion time. This decrease in compressive strength may be due to stretching of the gel into the pores and diffusion of solid moisturizing components due to the penetration of oil products into the microstructure of the concrete resulting in weak adhesion and cohesion forces in the cement in addition to the effects of oil products on concrete surface reactions, The apparent effect of the surface tension of ash particles and their connection to cement particles and how the ideal bonding to form a chemically and physically reactive substance comes due to the use of cementing with wood ash in low proportions, since cement particles do not interact with high relative amounts of wood ash.[22][23][24][25].

Splitting tensile strength test results:
Figures (4) and (5) summarize the results of the tensile strength values of different types of concrete at different periods of immersion in petroleum products with respect to reference concrete. The results showed that for all different types of concrete mixtures, the slip tensile strength showed a significant increase in all test periods for samples treated in water and then left in air. This increase occurs due to the continuous cement hydration process [15].

On the other hand, when the samples were exposed to petroleum products, they showed a decrease in tensile strength values within 90 days of exposure which may be due to the increase in water / cement the ratios and the sliding tensile strength. The magnitude of the decrease in the tensile strength values is clearly visible with the
4. Wood ash can be added to the concrete mixture to improve the thermal properties by increasing the number of air gaps in the rigid concrete, which leads to increase the thermal resistance. It is well known that wood ash is classified in type D according to the standard specifications of the American Society for testing materials [ASTM C494.71]

References


IV. CONCLUSION

1- The results value of testing for specimens continuously left in air increase with time increase with value 23 MPa (compression strength).
2- Specimens soaked in oil products show decrease in compressive strength and splitting tensile strength, values with time increase value with 5.8MPa.
3-Adding wood ash especially under pressure within recommended limits will produce concrete with high pores because the addition of wood ash leads to lower compressive strength compared with reference concrete.

Fig. (4) Splitting tensile strength results for plain concrete specimens at various ages of immersion in oil products and outdoor concrete.

Fig. (5) Splitting tensile strength results for wood ash concrete specimens at various ages of immersion in oil products and outdoor concrete.

Fig (6) the concrete specimens after splitting tensile test.


Measured the mechanical properties of thermoplastic polymers using in healthy applications

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Abstract- The use of polymeric materials that have good mechanical properties compared with metals, ceramic materials and woods is a good thing because they are characterized by low cost and high efficiency with the application performance that has been studied. Therefore, the study of these properties reflected the good application of the materials used without disadvantages, including polycarbonate, polypropylene and high-density polyethylene. The results showed an increase in the remarkable tensile properties of high-density polyethylene, high hardness of polycarbonate, and good compressive properties for all types. The optimal hygienic application of using such materials is in the field of preserving medicines and sanitary ware.

Index Terms—

1. INTRODUCTION

Medical applications are of very great importance and therefore the use of thermoplastics prompts them to withstand high temperatures, which facilitates their formation without reaching the melting point in many cases. Therefore, the development in the industry enables us to use thermoplastic materials with wide applications. The safe mechanical limits within the application of the field of work for these materials provide useful information to choose the appropriate type of operation, among which the most important are mechanical properties (hardness, durability, stress tolerance of all kinds, shock and other properties) [1].

The characterization of polymeric materials in their basic form for a set of properties and behavior in all their states as a liquid and molten solid. The changes that take place in the type of polymers, their properties and their behavior depend mainly on the compositions that make up the polymer of its kind and the temperature that the geometry or internal structure of the polymers bear. The polymer is described as a viscous liquid that does not have a known shape or flow. After the hardening process for all types of polymers, all kinds of mechanical, chemical, thermal or physical properties are determined, where the deformation is known under the influence of the applied load that is irreversible. While the rest of the flexible metallic materials such as steel and aluminum deform instantly under the influence of the load and return to the original state when the load is removed if the loads are determined to be within the limits of elasticity. Whereas, the solid polymer is capable of returning to its normal position even after the effective load has been removed.

The thermoplastic polymer resins bind their molecules as long polymers that do not bond with other components as shown in Figure (1).

Fig. 1: polymers chain

Therefore, thermoplastic resins can melt and solidify into granules repeatedly by heating and cooling. The temperature also heats the material and softens it to a degree of liquidity or melts so that it can be formed. Whereas, cooling in the grater works on thermoplastic polymeric materials to form and mold the material [2].

Ref. [3] the process of distinguishing between thermoplastics and long carbon fiber reinforced plastics depends on the type of polymer resins using five polymer resins such as polyamide 6, polyamide 6.6, polycarbonate, high density polyethylene and polypropylene which are supported with carbon fibers all by 30%. The different mechanical properties were also examined, and the reason for the difference in mechanical properties was considered by analyzing the adhesion properties. The appearance of fracture and adhesion between the fibers and the resin and its cause were observed.

The present work studies the possibility of investigating the mechanical properties of thermoplastic polymer matrix composites such as nanotubes. It was also used as the base material for acrylonitrile butadiene styrene (ABS) polymer. The addition of carbon nanoparticles was added as the support material, which was extruded by the extrusion machine as it was manufactured.

Ref. [4] the mechanical properties are measured, including tensile strength, bending, shear and compression, the tests are compared with the polymeric materials without the addition of the nanomaterial as the support. The comparison of the effect on the mechanical properties of the polymer material with carbon nanotubes and without fillers, where the importance of adding nanomaterials confirmed the clear improvement in the properties of polymers. The present work studies the possibility of investigating the mechanical properties of thermoplastic polymer matrix composites such as nanotubes. It was also used as the base material for acrylonitrile butadiene styrene (ABS) polymer. The addition of carbon nanoparticles was added as the support material, which was extruded by the extrusion machine.
as it was manufactured. During this work various mechanical properties are measured, including tensile strength, bending, shear and compression, the tests are compared with the polymeric materials without the addition of the nanomaterial as the support. The comparison of the effect on the mechanical properties of the polymer material with carbon nanotubes and without fillers, where the importance of adding nanomaterials confirmed the clear improvement in the properties of polymers. Ref. [5] The mechanical and dynamic properties of various types of polymers are studied, and the apparent deformation of the polymeric materials is described after the examination, by predicting the stress and strain curves of the polymers. The strain-strain curves of the tensile property of polymers were discussed, which was represented by measuring the toughness of the polymer by calculating the area under the curve. A theory of liquid polymer viscosity was also developed and a prediction of mechanical properties. Ref. [6] Polymers give thermoplastics their importance by the application in which they are identified where they have appeared in industrial applications. The materials also lose their properties due to environmental changes, which results in the applications they are intended to use in them, as well as in engineering applications. Cementing with nano-fillers helps to incorporate these polymers in engineering applications and reduce their failure during mechanical tests. In this study two types of polymers were used, polypropylene (PP) and high-density polyethylene (HDPE). Such compounds are exposed to a higher temperature to study the effect of age on the mechanical properties and fatigue of the nano-clay including the thermoplastic polymer PP / HDPE. Nanocomposites. Inclusion of Nano-clay minimizes the decrease in these properties due to thermal aging and polymer time progression. Ref. [7] In this study, composites reinforced with short glass fibers reinforced with the polymeric base material polyethylene elastomer (TCE) and poly oxymethylene (POM) filled with poly fluoro ethylene compound (PTFE), and micro fillers with different shapes such as short carbon fiber (SCF), silicon carbide (SiC) and alumina were prepared. (Al2O3). These materials were mixed by smelting and double extrusion. The most important mechanical properties that have been studied are tensile strength, bending and impact. The mechanical properties test results indicated that short glass fibers significantly improve the strength of the PTFE compounds filled with TCE and POM. Whereas, ceramic reinforced polymeric materials show more tensile and bending results of POM with PTFE simultaneously. The hybrid compounds with higher reinforcement ratio showed lower tensile strength and fatigue. The POM compounds exhibited better tensile strength (strength 75.78 and modulus 1769.1 MPa, respectively) and bending properties (strength of 116.2 and modulus of 5697 MPa respectively). TCE compounds showed moderate elongation at breakage and better impact strengths of up to 80 joules / m (with a glass fiber content of 20 wt.%) compared to POM compounds. Ref. [8] studied the effect of graphene nanoparticles (GNPs) on the physical-mechanical properties of short carbon fibers (SCF) reinforced polyamide 66 / thermoplastic elastomer compounds was investigated. The results are supported by nanoscale graphene. Density, stiffness, tensile and flexural properties were also examined as per ASTM standard. The decrease in the fiber content reduced the fiber stiffening <1% but GNPs were able to maintain the strength of the strengthening effect. The stiffness and impact strength values were also increased by 2% by weight of graphene. The reason for higher nano plate loading values is the surface dispersion that develops the relationship between Hardness and impact strength. Loading the nanoparticles from graphene took advantage of the tensile property. While for the same reason the values of the bending strength decreased. The modulus of bending increases to 2 by weight. %. The results of the mechanical properties when loading GNP showed a drastic decrease when compared to the results obtained when reinforcing the polymer with short glass fibers. Fortification of 2 wt% platelet nanoparticles from graphene gave good results and has been used in many applications subjected to different mechanical loads. The morphology of the fractured surfaces was studied by analyzing the image-scanning electron microscope to understand the various features and mechanisms. Ref.[9] nanofibers by using a wet disk to grind wood flour. Two types of polymers were combined ethylene-butene polymer with wood flour or lignocellulose nanofibers to prepare different main composites. This process included where the polymerization took place by heating water to 105 degrees. These main compounds were also combined again with polypropylene to obtain the final compounds. The fact that the co-polymer of ethylene-butene is considered a rubber material, and that the combination with this material raised the values of durability while reducing the stiffness, and on the contrary, the compounds supported by nano-cellulose fibers and wood flour showed very high resistance values relative to the substrate in terms of bending and production pressures slightly higher than Ethylene-Butene / Polypropylene Blend. Also, woodmeal compounds exhibited brittle fractures that reflect the change of the polymeric nature and breakage of the polymeric chains due to the incorporation of wood flour with the polymer during tensile tests and had a lower impact strength than that of the ethylene-bute / polypropylene blends. On the other hand, the addition of lignocellulose nanofibers did not reduce the effect strength of ethylene - biotin / polypropylene. Ref. [10] development is increasing interest in using fibers as a development material for production, the thermoplastic polymeric composites used in a wide range of products encompass all their applications For many economic and production reasons, they changed the openness of the world towards the use of such compounds Thermoplastic. It acquired commercial fiber-reinforced thermoplastic matrix compounds, Success in semi-structural and structural applications. In which fibers of all kinds are used to support the base material in a thermoplastic polypropylene (PP) matrix to prepare composite materials.

In this paper, the mechanical properties of fiber-reinforced PP compounds (FRPCs) were studied by means of many results. The properties were studied and these results were analyzed, which showed improvement in the mechanical properties to be developed through the fusion and adhesion strength between the fibers and the incubator. Ref. [11] The current study examines the change in the added percentages of natural rubber on polypropylene Where different blends were prepared by melting the Natural Rubber Compound (ENR). The PP / ENR blends were prepared by compound smelting using an internal mixer and smelted.
Through vulcanization. Mechanical tests such as tensile test, hardness test and impact test are performed. To analyze the results of properties that showed an improvement in strength and elongation upon tensile strength, and a decrease in the values of hardness and tensile strength, as this decrease was related to the amount of changes transmitted by the elastic chains.

Ref. [12] In this study, high-density polyethylene (HDPE) was used with calcium silicate, where the samples were made by injection. The reinforcement process led to a significant increase in the yield and tensile stresses, and a decrease in the amount of elongation was observed at the fracture stages. For composites, it can be concluded that the modified calcium silicate played a role in enhancing the mechanical properties of HDPE, which was represented by a slight improvement in properties and reduced other properties, the main objective of which is to provide a wide range of materials that are used in many applications.

Ref. [13] The development in the use of nanomaterials has prompted many researchers to study the ability of nanomaterials to be supported with various incubators, especially thermoplastic polymers. Addition ratios change when reinforcing for multi-walled carbon nanotubes with high-density polyethylene nanocomposites (MWCNT / HDPE). Multi-walled carbon nanotubes (MWCNTs) were incorporated into a high-density polyethylene (HDPE) matrix using twin-screw extrusion and injection technology. High-density polyethylene, which was reinforced with different proportions (1%, 3% and 5%), was produced from the carbon nanotubes in the form of rods and the best results were for the reinforcement ratios (3%). Where the results showed the ability of the compounds to improve the mechanical properties clearly.[14]

But the properties of this type of polyethylene are affected (additives and development of polymerization methods) have good tensile strength. Good heat and chemical resistance and crack resistance [17]. Table (1) shows the characteristics of HDPE [18].

Polypropylene: This type has good insulation and good chemical resistance to corrosive solutions and is not affected by soil, ferrous acids or alkalis and many organic mixtures except for periodic components (hydrocarbon compound) cause swelling of the polypropylene surface [19]. Table No. (1) shows the mechanical, thermal and electrical properties of polypropylene [20].

2.2. Method

Extrusion method: It is an industrial method of use employed to manufacture thermoplastic polymeric products, where extrusion dies are used to produce continuous shapes such as plates, tubes, rods, channels and films [21]. Many polymeric models for the materials used in this study were manufactured, in which they were used with single-screw confidence and different temperatures depending on the type of polymer and its ability to withstand temperatures, as shown in Table 2. Figure 2 shows the extruder used to produce polymer strips.

Table (1): Properties of polymer used for Research extrusion

<table>
<thead>
<tr>
<th>properties</th>
<th>Poly carbonate</th>
<th>Poly propylene</th>
<th>High density polyethylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>1.2</td>
<td>0.902-0.96</td>
<td>0.900-0.91</td>
</tr>
<tr>
<td>Tensile strength (Mpa)</td>
<td>62.05</td>
<td>37.9</td>
<td>27</td>
</tr>
<tr>
<td>Tensile modulus (Mpa)</td>
<td>34.4</td>
<td>15.5</td>
<td>27</td>
</tr>
<tr>
<td>Impact strength izod (KJ/m³)</td>
<td>12-17.5</td>
<td>0.5-2</td>
<td>1-9</td>
</tr>
<tr>
<td>Hardness, Rockwell</td>
<td>M70, R1</td>
<td>R85-110</td>
<td>D45-50</td>
</tr>
</tbody>
</table>

Table (2): polymers melting temperatures

<table>
<thead>
<tr>
<th>Polymers blends</th>
<th>Temperature °C</th>
<th>Screw speed Cycle per min.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zone 1</td>
<td>Zone 2</td>
</tr>
<tr>
<td>PC</td>
<td>220</td>
<td>200</td>
</tr>
<tr>
<td>PP</td>
<td>190</td>
<td>170</td>
</tr>
<tr>
<td>HDPE</td>
<td>180</td>
<td>160</td>
</tr>
</tbody>
</table>
Samples dimensions and standard specifications for the testing specimens. According standardization

<table>
<thead>
<tr>
<th>Test</th>
<th>Sample dimensions</th>
<th>Standard Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>impact</td>
<td><img src="image1.png" alt="Impact sample" /></td>
<td>ISO-179</td>
</tr>
<tr>
<td>tensile</td>
<td><img src="image2.png" alt="Tensile sample" /></td>
<td>ASTM-D638</td>
</tr>
</tbody>
</table>

2.3. Test procedure

Impact resistance Charpy type test: (Charpy test) IMI manufacturer by Amityville / New York. Where the manufactured model is installed within the international specifications as shown in Table 3 horizontally at the bottom of the device and the fixed arm is released to direct a shock blow to the model and the absorbed energy, as shown in fig.(3) which gives the shock resistance index, is calculated divided by the cross-sectional area to which the blow was directed as shown in Equation No. 1[21]

\[
I_S = \frac{UC}{A} \quad \text{..............(1)}
\]

whereas:
UC: is the fracture energy (KJoule), which is determined by the Sharpay Impact Test instrument.
A: It is the cross-sectional area of the sample.

Tensile test Tensile Test Instrument:
Model 1195 manufactured by (Instron). After longitudinal fixing of the specimen by the upper and lower jaws of the equipment, preparing as table 3, a tensile load is applied at max. Load (500Kg), at velocity rate (2mm/min), and by utilization of the connected graphic plotter, the relation of \((P - \Delta l)\) is obtained as shown in Fig.(4). This relationship would be modified to relationship of (stress – strain) \((\sigma - \varepsilon)\) to calculate the ultimate tensile strength (UTS) for the specimens as equation 2 and 3[22]

\[
\sigma = \frac{P}{A} \quad \text{(2)}
\]

Where: P: load (N) A: cross sectional area

\[
\varepsilon = \frac{\Delta l}{l} \quad \text{(3)}
\]

\(A. \text{ Where: } \Delta l: \text{ length change, } l: \text{ original length}\)

2.4. Hardness test (Shore D method)

The device is the standard model D-39576 manufactured from Sendle - Germany. This tool is used to measure the hardness of thermoplastic polymers, where the samples are measured by stitching the tool needle, which gives an indication of the value and the amount of hardness as fig. (5) [23]
3. Results

All the experimental results that are obtained from the mechanical and physical tests under investigation. The experimental tests and the results including (tensile test, impact test, and hardness test)

3.1. Tensile Test Results

Tensile test has been measured for all type of blends, with composites, Fig(1) shows the (stress- strain) curves of pure polymers (100% PC, 100% PP, 100% HDPE) as (P₁, P₂, P₃) respectively, it is generally known that the (PC) is a hard, brittle polymer, and the facture mode of this type of thermo plastic polymers brittle mode, and that shows how this material will behave under load extension test. In general, it is known that (PC) is a hard and brittle polymer, and this is what makes it withstand compressive loads more than tensile loads as it appeared clear and clear the fragile behavior and did not show any significant strain or clear elongation compared with other polymers, where the polypropylene polymer showed a show of tensile strength Less elongation and greater than that of polycarbonate, but when compared with the high-density polyethylene polymer, it shows a high elongation relative to the rest of the polymers, which is attributed to the type of polymeric chains to which they are linked and the forces controlling the molecules of this type of polymers, which break if exposed to intense loads and high temperatures. As shown in Figure (6) Ref. [24]

We can also measure the maximum tensile strength of these polymers and compare them with the maximum shear resistance as shown in Figure (7), which was 8% less than the amount of tensile strength values, as this is reflected in the nature of these polymers and the engineering behavior of the single polymer chains and how they slip when vertical loading or loading Shear, where it is found that the amount of shear resistors is less than the tensile resistors [24][25].

3.2. Impact results

The results of the shock resistance measurement depend on the type of polymer examined during the test, which gave predictable results for the nature of the polymer, as the polycarbonate polymer achieved an increase in the energy value absorbed during the fracture area, which was close to the standard values and according to the nature of the polymer, while polypropylene was less than polycarbonate and high density polyethylene. Because of the weakness of the bonds and the binding forces in it, as shown in Figure (8) [26]-[27].

3.3. Hardness shore D

Shore D) is a polymer stiffness measurement test because the (PC) value is higher than (PP and HDPE) due to the nature of the polymer structure, which is made up of a long-branched polymer chain. The arrangement of molecules makes these polymers have a higher ability to absorb energy and the cross-linked polymer has stronger bonds, which makes these polymers tough and usually hardness is a measure of toughness and mechanical resistances, making them closely related to tensile strength and the test results show that the highest hardness of polycarbonate, polypropylene and high polyethylene Density is respectively as shown in Figure (9) [27].
4. Conclusions

Based on experimental results, which are presented in this work, the following conclusions can be drawn:

1. Thermoplastic polymers using must be have similar melting point to prevent non-homogeneity the polymer particles.
2. Different mechanical properties of Thermos plastics polymers according the nature of polymer and forces of polymer chains.
3. Tensile strength always high than shear strength (0.8).
4. Impact strength and hardness have good values

References


