PETROCHEMICAL POLYMERS AND TECHNICAL TEXTILE INDUSTRY IN THE KINGDOM OF SAUDI ARABIA

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Abstract: *This paper aims to explore the industrial environment of petrochemicals and technical textile in the Kingdom of Saudi Arabia, where it links the abundant availability of synthetic polymer, as a "national wealth" of high quality and sustainability standards, with its importance in the technical textile industry. The paper discusses the future trend and economic relevance of polymers and technical textile, as well as the challenges that face this industry in Saudi Arabia. Findings of this research, have pointed out that abundant availability of raw polymers in the Kingdom contributes to accelerating the manufacturing process of technical textile. In addition, it has also indicated that the Kingdom has natural and economic environment, favorable to the technical textile industry that relies on cutting-edge technology which eliminated the need to hire great number of technicians. In addition, the manufacturing process of technical textile now relies on thermal processes instead of water as an alternative to preserve the water wealth, thus, making the Saudi natural and economic environment favorable to this industry. The research has also highlighted the Kingdom's development plans as well as its future vision that aims to promote the petrochemical industries and enhance various respective products, given their economic and investment strength that contributes to the growth of non-oil industries in the Kingdom of Saudi Arabia.*

Keywords: *Petrochemical industry, synthetic polymers, technical textile, sustainability.*

1 INTRODUCTION

The world has experienced a significant transformative revolution in petrochemical industries, which has become today's industrial tool. Thus, the entire world has shifted from the Iron and Stone ages to the age of chemistry, with petrochemicals being utilized in the manufacture of various products that we use in daily lives, including furniture, clothes, devices, vehicles, and even in the construction of bridges, roads and buildings.

Today, the Kingdom of Saudi Arabia has emerged as one of the world's largest producer of petrochemical industries, due to abundant availability of stockpiles of crude oil and natural gas. Moreover, the Saudi petrochemical industry has seen increasing growth rates in recent years, and the country's total production of petrochemical materials, chemicals and polymers is projected to increase to 115 million tons in the coming years [1].

The Kingdom's Ministry of Energy has aimed at achieving sustainable development for the integrated industry of oil, gas and mining, in order to achieve the highest added value to the national economy [2]. Thus, the petrochemical materials industry has outweighed that of non-oil industries in terms of investment volume, with an investment value of approx. SAR 532 billion, i.e. 50% of the total investments of producing factories [3].

Nowadays, Saudi Arabia produces various petrochemical products in addition to fertilizers, including the five main plastic polymers, which are polyethylene (both low-density and high-density polyethylene), polypropylene fibers, polystyrene, plastic and polyester [4-6]. Moreover, the year 2018 has shown further innovations, including the introduction of special portfolio of textile polymers, as well as innovative sustainable solutions for synthetic polymers [7].

The demand for technical textile-based products is constantly increasing. In 2017 alone, the volume of technical textile market (both woven and non-woven) was estimated at USD 165.51 billion, and it is likely to reach USD 220.37 billion by 2022, at a CAGR of 5.89% from 2017 [8-10]. Moreover, reports on global textile market and its future expectations have predicted an increase in the market value of technical textile to reach USD 220.37 billion by 2022 [11].

This increased demand on technical textile may be attributed to its physical, mechanical and dynamic characteristics, which are utilized in heavy and light industries. In addition, the increased use of technical textile in many end-uses industries (such as aggrotech, buildtech, mobiltech and geotech) has further increased the demand on it [8, 12].

Both technical fiber and textile are also utilized in the production of variety of clothes and products, including protective, functional, meditech and health, sporttech and smart clothes. Consequently, the shirt we wear is made of polyester, shoes and bags are

made of polyvinyl [13], flame- and fire-resistant clothing, and military clothing are made of nano and synthetic polymers [14-16]. Additionally, the carpets and bedspreads are made of polypropylene, while the fabric used in the manufacture of fire- resistant tents that are commonly found at the sacred sites during pilgrimage, is a sort of highly effective fire-resistant petrochemical-based polymers [17, 18]. Currently, the world's is trending towards clothes, furnishings, leather and nylon that are made of petrochemical-based synthetic textiles [17]. The textile industry is an important segment of the Kingdom's industrial sector. It plays an important role in creating job opportunities for Saudi citizens, diversifies their sources of income, and helps overcome the problem of unemployment. Moreover, this industry contributes to increased production rates, leads to economic independence and provides some local needs of clothing and textile [19, 20].

In light of the research's exploratory study which has included field visits to Saudi petrochemical and technical textile factories, as well as face-to-face interviews with concerned staff, it was found out that there is a need to pay attention to technical textile industry in Saudi's market, which is known for its global competitive strength, thanks to the abundant availability of crude oil stockpiles on the Kingdom's soil as a "national wealth" and the possibility to transform quantities of this oil into non-oil transformative industries, in line with the Kingdom's 2030 vision.

2 PETROCHEMICAL AND POLYMERS - FUTURE VISION

The Kingdom's petrochemical industry constitutes a vital component of Saudi non-oil economy. It also supports the transformative industry and international investments, helps leverage the country's economy, supports the industry sector, and provides job opportunities for the citizens [21, 22].

In the meantime, petrochemical industry has the potential to open the local markets to some new products, while, at the same time, reduce reliance on imports. Moreover, studies have indicated that the government has already taken steps to encourage the inflow of foreign direct investment in the petrochemical industry. However, these studies have also noted that several measures related to infrastructure and security factors need to be taken [23]. These facts were highlighted by the National Transformation Program 2020 (a.k.a., the Kingdom's Vision 2030), given the prominent role of petrochemicals industry in the non-oil economy, being one of the important sectors that achieve the aspired objective to diversify resources of national income away from reliance on oil [2, 24]. As per annual reports of the Ministry of Energy, total exports of the Kingdom's petrochemical and plastic amounted to $ 30 billion in 2017, while petrochemicals accounted for a large proportion of the total non-oil exports, amounting to 60%. The reports have also predicted that the petrochemical industries sector will help increase the production capacity so as to produce specialized chemicals and end-uses products. This will not only achieve growth in the Kingdom's non-oil exports, but will also create job opportunities for Saudi citizens [3]. Planning the future of petrochemical industry, the Ministry of Energy, in collaboration with the Saudi Industrial Development Fund, has aimed to achieve sustainable development for the integrated industry of oil, gas and mining, in order to achieve the highest added value to the national economy, and work towards discovering and exploiting more resources of oil, gas and minerals in the Kingdom, in order to generate the highest returns from these resources, especially as the production capacity of the petrochemical sector is constantly growing and increasing as shown in Figure 1 [24].

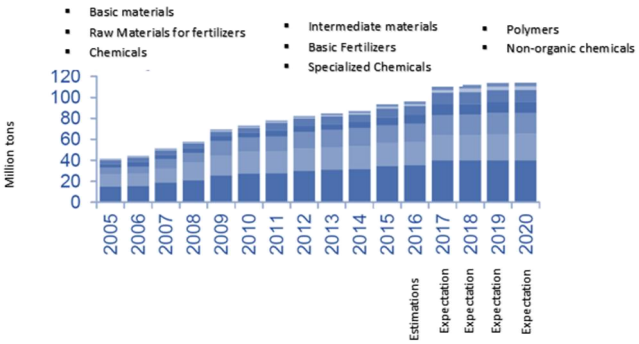

Figure 1 Production capacity of the Saudi petrochemical sector (2005-2020) [24]

3 PETROCHEMICAL PRODUCTS: POLYMERS

Saudi Arabia produces many petrochemical products such as plastic polymers, which are polyethylene (both low-density and high-density polyethylene), polypropylene fibers, polystyrene, plastic and polyester. It does also produce more than 2 million tons of methanol and a similar amount of MTBE (Methyl tert-butyl ether) which are widely used as additives in gasoline. Recently, a new project was launched with the aim to produce 140,000 metric tons of polyester fibers and PET pellets, which are used in the manufacture of bottles and textile [4-6].

In 2017, a project proposal was presented to convert quantities of oil into chemicals, with the aim to produce 9 million tons of petrochemical materials per year through treatment of 400,000 barrels of crude oil per day, and with an optimal integration between plants and petrochemical refineries. Moreover, polymeric materials have gained the interest of industrial consumers over the past 70 years, resulting in an increased production of polymers portfolios, and addition of demand-driven

characteristics, including viscosity, conductivity, shielding, thermal management, flame resistance, and the overall aspect that enhances the performance of its multiple uses [7].

The Kingdom's petrochemical companies manufacture the building blocks for chemicals that are utilized in several industrial activities, including but not limited to packaging industry, and manufacturing of health care devices and household necessities. Moreover, the year 2018 has witnessed further innovations with the introduction of the premium portfolio of textile polymers [7]. In an interview held within the exploratory study of this research, a representative of the most famous petrochemical companies in the Kingdom has valued the quality of Saudi polymers, citing its high quality and conformity to standard international specifications as well as its similarity to products of Europe and other foreign countries. This can be attributed to the fact that most companies in Saudi Arabia are associated with partnerships with peer companies in Europe and other foreign countries, and therefore employ the same technology used by those foreign countries.

4 POLYMERS AND TECHNICAL TEXTILES

The exploratory study has shown that the Kingdom manufactures polymers that are used in the textile industry, including acrylic fibers, nylon, elastane (a.k.a. spandex), polyester fibers among others, which are all available in the Kingdom's factories and are also exported. As per the study's exploratory interviews, the most important countries to which the Kingdom exports textile polymers are China, India, Vietnam and Bangladesh, while it exports less to Europe, America and Turkey. However, in terms of local demand on petrochemical polymers, the exploratory study has shown that local demand on textile polymers, such as polyester, is weak compared to a stronger external demand. However, this was attributed to lack of textile factories in the Kingdom. These findings were verified by global reports and statements, including the announcement by the International Energy Agency during its International Conference on the Future of Petrochemistry, during which statistics of countries that use the most synthetic threads in the textile industry, such as polyester, polyamide and acrylic, were revealed. As per these statistics, the USA, Europe, China and India have had the highest consumption rates between 2002-2014. Meanwhile, the organization has revealed that future global trend in the textile and clothing industry demands polyester over other types of threads [25]. This was further confirmed by another study in which it was maintained that the global demand for polyester exceeds that of natural threads such as cotton and wool, at an average of 60% of the total global demand for threads that are utilized in production.

The results of the exploratory study have shown that various technical types of textile polymers are being produced in the Kingdom's petrochemical factories. Figure 2 illustrates the production stages of polymers, starting with treatment of crude oil and natural gas, to the production of ready-to-use petrochemical-based synthetic polymers. These production stages include specialized refining and manufacturing processes along with various chemical treatments, and are supervised and managed by industry-experienced, and specialized technical team throughout the whole production process, until the delivery of the product in its final form. Thus, it can be concluded that the availability of local petrochemical-based textile polymers can support derivative transformative industry, such as textile industry (including technical textile). Moreover, availability of polymers at the local level can promote production, while utilizing crude oil for the manufacture of polymers can help improve the rates of national productivity.

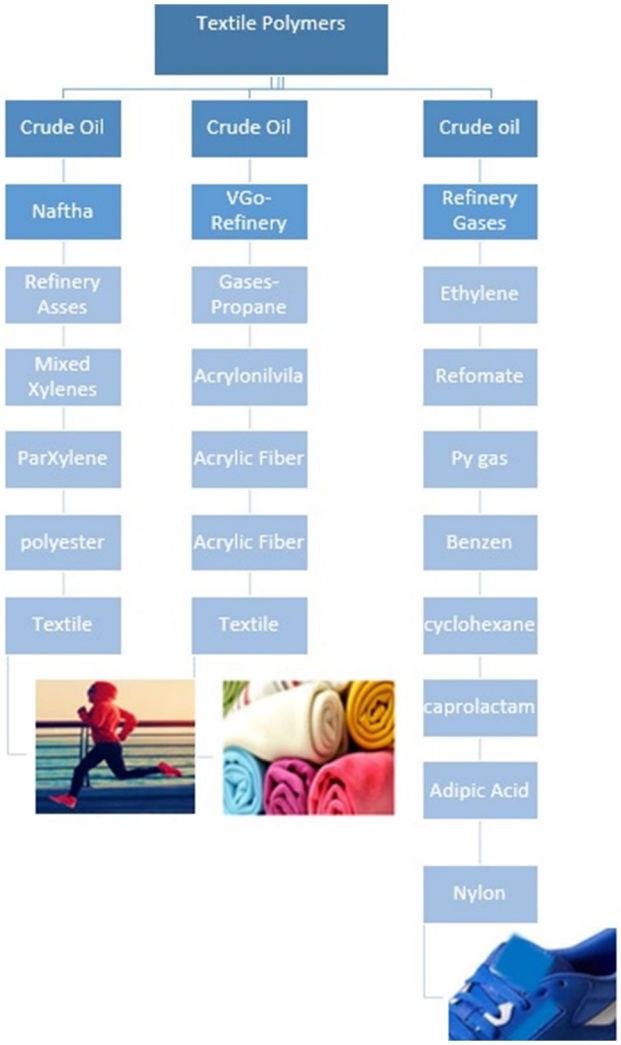

Figure 2 Production stages of textile polymers in Saudi Arabia petrochemical factories

5 POLYMER INDUSTRY'S CONTRIBUTION TO SUSTAINABILITY

The concept of global sustainability is closely linked to the petrochemical industries in the Kingdom of Saudi Arabia, and some Saudi petrochemical companies have conducted researches and studies that link sustainability to petrochemical products. Moreover, sustainability helps Saudi petrochemical companies realize their future orientations towards achieving the economic, environmental and social pillars of sustainability. In addition, sustainability promotes financial performance by achieving efficiency that reduces operating costs, as well as by developing innovative sustainability solutions for products, in order to increase profitability [23].

The Kingdom is striving to invest in research and development initiatives to achieve sustainability for its products, and convert plastic waste into feedstock and chemicals. In this regard, a Saudi company was ranked the third best petrochemical company for the year 2018 in FORBES Classification for its operations in more than 50 countries to make positive impact on the communities where it operates through sustainability. The company has implemented a successful experiment to convert plastic waste into feedstocks as shown in in Figure 3.

Building on this success, the Kingdom issued a decision to build a plant in the Netherlands to produce raw material from recycled plastic waste, thus ending the previous practice of incinerating waste materials or burying them in landfills. Thus, the Kingdom has become the first country to implement such a project [28]. The research sample has indicated that the Kingdom's companies pursue several aspects of developments in the sustainability processes, including the reduction of carbon footprint of waste and production processes, through the application of alternative environment-friendly solutions. On this regard, sustainability reports have confirmed that the Kingdom's companies registered 11,738 patents in the petrochemical sector and its sustainability [26].

6 SYNESTHETIC TECHNICAL TEXTILE INDUSTRY IN THE KINGDOM OF SAUDI ARABIA

The Saudi local market produces petrochemical-based textile products, according to the study's exploratory interviews with officials in the technical textile sector. Given the importance of the technical textile industry as being one of the promising sectors, a number of textile factories that produce different products were established. These factories produce fibers as well as other textile threads that are used in manufacturing different industrial products (such as bags that are used for packaging of onion and rice; special textiles that are utilized in construction of bridges and roads; as well as textiles used for manufacturing of umbrellas, tents, (especially tents that are commonly used in the sacred sites during time of pilgrimage) and furniture. These textile factories use raw materials that are utilized in the manufacture of petrochemical-based synthetic textiles (such as propylene, polyethylene, polyester and nylon) and others.

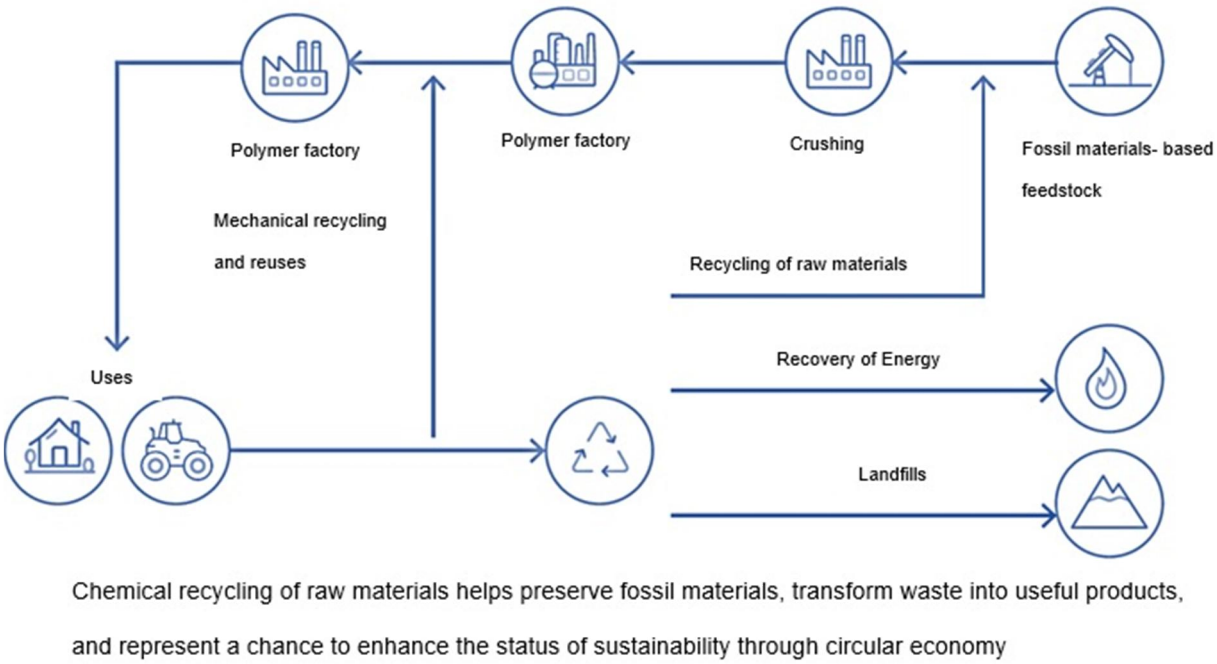

Figure 3 Transforming plastic materials into raw materials for the production of chemicals [26]

7 GOVERNMENT INDUSTRIAL SUPPORT FOR PRODUCTS MADE OF PETROCHEMICAL-BASED TEXTILE IN THE KINGDOM OF ARABIA

Saudi government impose laws that stipulate the sale of all kinds of local polymers to Saudi national factories at a low price [2]. In addition, the Kingdom's 2030 vision avails its support to the petrochemical sector, considering it as one of the sectors that will help boost the non-oil exports. As per the vision, the Saudi petrochemicals industry has been designated as one of the seven national industries selected for concentrated support. Specifically, the Vision emphasizes the need to build a unique logistical hub in the Kingdom, in which the enhancement of logistical services, state-of-the-art infrastructure, and streamlined trade exchanges are sought. Additionally, the vision also emphasizes support for national companies, including petrochemicals, in helping them gain market share in both regional and international markets [24].

Consistent with government decisions, the research's exploratory study has shown how the government avails its support to polymer products, including by imposition of laws that encourage petrochemical companies to avail special prices to local companies that produce polymer-based products, and stipulate the sale of polymer-based products in the local market at a lower prices compared to export prices.

Additionally, national factories of various industrial activities have confirmed receipt of supplies of all types of petrochemical materials and their derivatives, including the chemically treated polyesters that are used for the manufacturing of carpets as well as for tents that are commonly used in the sacred sites during time of pilgrimage.

Thus, it is clear that government support for local polymers and availability of raw materials in the local market at a competitive price can save a lot of time and effort, contribute to the development of local industries, and accelerate the production process of technical textile-based products.

8 OUTPUTS OF TECHNICAL TEXTILE SECTOR IN THE KINGDOM OF SAUDI ARABIA

The study's exploratory interviews have indicated that 30% of factories that manufacture technical textile cover the needs of government projects at the local market, including factories that rely on government projects (such as factories that manufacture tents for sacred sites and provide materials for construction of airports), while 20% of factories cover the consumers' needs of functional textiles, (such as medical masks and carpets), and 50% export their products.

The Kingdom's petrochemical companies focus their attention on the production of new groups of technical textile products. In 2018, the Kingdom launched UDMAX™ GPE 46, a unidirectional fiber-reinforced thermoplastic composite tape that can be used to reinforce industrial oil pipes, boilers and storage tanks. This can significantly increase strength performance while reducing weight and corrosion in the most demanding environments.

In the health and medical textiles sector, new fibers were introduced in 2018 as an innovative new product made of polypropylene resins, and engineered to enable manufacturers produce non-woven fabrics of light thickness and different characteristics, including air permeability and thermal insulation. In addition, this material meets the rigorous standards of hygiene and consumer protection, which makes it highly candidate for use in a wide range of medical and health applications, including diapers, sanitary napkins, to patient gowns and medical clothing [26].

Resin can be easily designed according to specific requirements as per customer demand, and can help manufacturers produce fabrics that combine unique advantages, including excellent processing features, high performance, control over costs and manufacturing requirements, and sustainability, while observing customers' safety and comfort [26].

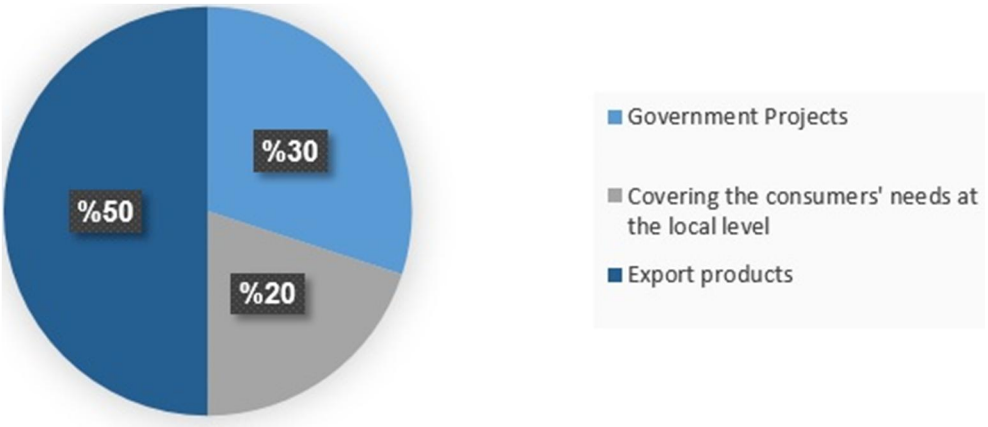

Figure 4 Outputs of technical textile sector in the Kingdom of Saudi Arabia

Reflecting on the research's exploratory study, the Kingdom was found to have many effective technical textile factories that use locally-manufactured textiles polymers (such as propylene and polyester used for the manufacturing of carpets, medical tissues and flame-resistant tents that are specially made for the sacred sites). In addition, these factories have proved its capacity to cover both local and global needs, as well as its ability to deal with the challenges that face the textile industry in the Kingdom. These findings can encourage the implementation of more industrial activities (similar to the industry of petrochemical-based technical textile), that are manufactured and produced using cutting-edge technological machines which have proved its capability and effectiveness in current factories.

9 CHALLENGES FACING THE TECHNICAL TEXTILE INDUSTRY IN THE KINGDOM OF SAUDI ARABIA

The Kingdom's natural and economic environment is considered favorable to the technical textile industry, as there are no major technical or natural problems hindering the manufacturing of polymer-derived textile. This can be attributed to the industry's reliance on advanced technological machines that have overcome many technical and natural problems, such as the need to use huge amounts of water for manufacturing of natural textile. Most of these new machines are powered by energy and heat, and no longer need abundant water.

The manufacturing of polymers-based technical textile relies on advanced machines as demonstrated by the research's exploratory interviews, and the factor of human manpower does no longer represent an obstacle to this industry, thanks to the advanced machines that are run by only few operators and technicians. Thus, it can be concluded that the manufacturing of all kinds of technical textile can be smoothly managed in the industrial environment of the Kingdom.

On a different note, excessive reliance on non-Saudi manpower represents a key challenge in Saudi labor market according to JADWA Investment reports [24]. Manufacturing is one of the sectors that contribute to improving the overall Saudization process and employment rates. However, the main challenge lies in the low number of graduate technicians, with a remarkable drop of enrollment in technical specialty in the Kingdom in recent years. However, this problem has been touched upon in the 2030 transformation program, which underscored the need to increase the numbers of mining and petroleum graduates so as to cope with changes, and have qualified persons for the industry.

10 GLOBAL CHALLENGES FACING THE INDUSTRY OF PETROCHEMICAL-BASED TEXTILE IN KSA

The most important external challenges facing manufacturers of petrochemical-based textile are the economic fluctuations, in light of the Kingdom's accession to the World Trade Organization [24]. Another remarkable challenge lies in competitiveness among leading manufacturing countries of technical textile-based products and clothing fabrics, which greatly affect the Saudi productivity and exports, as they offer lower competitive prices due to availability of low-paid manpower and low prices of their products. Hence, it is necessary to provide protective systems for the national technical textile-based products and clothing fabrics [27].

Figure 5 Global challenges facing the industry of petrochemical-based textile in KSA

11 CONCLUSION

Current global reliance is oriented towards achieving sustainable development for synthetic polymers and technical textile industry, given their respective high value that promotes civil and economic progress. The Saudi petrochemical industries have seen increasing growth rates in recent years, and the country's production of synthetic polymers is projected to increase to 115 million tons in the coming years. It is crucial to make use of the Kingdom's synthetic polymers for the development of Saudi technical textile industries, given the Kingdom's natural and economic environment which is favorable to textile industry, thanks to the industry's reliance on advanced machines that eliminated the burden to hire big numbers of foreign technicians, as well as its reliance on high heat and pressure processes instead of excessive and wasteful use of water resources. This sector has a promising future in the Saudi market and has been touched upon by the Kingdom's development plans and future vision as an area that provides investment opportunities in the sector of petrochemical products and respective derivatives. Thus, this industry can help reduce reliance on oil, and oil's revenues can instead be invested in the industrial development [24].

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