E-ISSN: 2829-7687
Journal of Fibers and Polymer Composites
Vol. 5 No. 2 (2026): 160-176

Curve Fitting of the Transport Behaviour of Epoxy Coated Fabrics through some selected Solvents

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Abstract. *Modelling of the Transport Behaviour of selected solvents through Epoxy Coated Grey Fabrics had been carried out. The epoxy coated fabrics were formulated by coating the grey states of cotton (EC), nylon (EN), linen (EN), polyester (EP) with epoxy resin as published. 20ml of Hydrogen peroxide was mixed with colbalt and methyl ethyl ketone to form mixture 1, 20ml of borax was mixed with cobalt, and methyl ethyl ketone peroxide to form mixture 2. 40ml of epoxy was measured out in a beaker and poured into a basin and 20ml each of mixture 1 and 2 were injected gradually at different points in the basin. The grey fabrics were then dipped in each of mixtures to form epoxy coated grey fabric. The methyl ethyl ketone peroxide (MEKP) and cobalt were used as catalyst and accelerator respectively. The grey fabric were then dipped in the mixture of 1 and epoxy and 2 and epoxy to form epoxy coated grey fabrics and allowed to cool at room temperature. The epxy grey coated fabrics were totally immersed in water bath at temperatures of 18°C and 27°C at intervals of 300 seconds until equilibrium was reached. Sorption properties were calculated using the molar percentage uptake (q_t) obtained from molar uptake at equilibrium (q_e). The results obtained were validated using the least square technique with Matlab software. The epoxy grey coated fabrics were characterized using Scanning Electron Microscope (SEM) and Fourier Transport Infrared Spectroscopy (FTIR) to examine the internal structure, and functional groups. Results obtained indicated that the molar uptake of both composites followed the typical isotherm curves. The enthalpy of sorption obtained was positive and suggested Henrys type of sorption. The epoxy coated grey fabrics reached equilibrium at shortest time for the 18°C while 27°C took longer time. Elemental composition of the epoxy coated grey fabrics were obtained using the elemental dispersive X-Ray from SEM; they indicated presence of carbon, oxygen, sodium, potassium, silicon, calcium, aluminum, magnesium and iron.*

Keywords: *curve fitting; transport mechanism; coating; solvents; fabrics.*

Type of the Paper: Regular Article.

1. Introduction

Fabrics coated with epoxy in contact with organic solvents have not been researched extensively. The morphological properties of these epoxy coated fabrics in equilibrium with organic solvents have also been largely unexplored, despite their relevance for many applications. This has given rise to this study.

Fabrics of different count and weaving number are permeable and their barrier properties are responsible for their suitability in a giving application. Ineffective barrier properties render enclosed

https://doi.org/10.55043/jfpc.v5i2.482
Received October 23, 2025; Received in revised form June 23, 2026; Accepted July 23, 2026; Published July 27, 2026
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products vulnerable to environmental factors such as oxygen, water and chemicals. Generally, the ambient temperature and processing parameters affect the barrier properties of polymers.

Textile structures provide a huge potential for the design and manufacture of varieties of products, because the resulting reinforcements have their own features that become translated into useful products and services. Fabric composites have found usefulness in the construction industry, there is the problem of degradation that occurs in environment with chemicals. The fabrics used in slope management degrade with time, hence the introduction of epoxy coated grey fabrics to address the problem.

There had been fewer reports on the sorption isotherms of various materials used in building, road construction, food packaging, barrier materials for erosion control and laboratory benches and floors. Each day materials come in contact during service with very strong toxic chemicals causing degradation to fabric due to swelling. The use of epoxy in filling the interstices will make it hydrophobic due to its barrier properties.

The need for transport behaviour of epoxy coated grey fabrics for the handling of organic chemicals that will prevent leakages and miscibility. The challenge of correct prediction of transport behaviour of epoxy coated grey fabrics and composites are froth with a lot of difficulties. The use of mathematical models generated from established isotherm and pseudoplastic first order models would make the studies less tedious and attractive.

The main objective of the present work is to study the transport behaviour of some selected solvents through epoxy coated grey fabrics. The specific objectives of the work are to: investigate the properties of epoxy coated fabrics made from natural and synthetic fabrics, the effect of chemical treatment on the sorption properties of epoxy coated grey fabrics, determine the isotherm and kinetic rates of sorption of the epoxy coated grey fabrics and validate the experimental results using curve fitting.

The development of fabric composites that possess the requisite properties to overcome the challenges enumerated in the problem statement. The use of epoxy resin, a strong and chemical resistant matrix would reduce the chances of failure and render the fabric composite impermeable to organic solvents. Epoxy polymers are famous for their superior barrier properties in various environmental conditions. This is evident in the modification of epoxy to balance the hydrophilic-hydrophobic properties and as such control the absorption, cross-linking and degradation. The use of borax for the treatment of grey fabric which is not reactive to water, oxygen, alkalis and acids would give synergetic hydrophobic properties in outdoor environments.

The curve fitting of the transport behavior of epoxy-coated fabrics (such as grey cotton, nylon, linen, and polyester) in selected solvents (e.g., acetone, chlorobenzene) is generally modeled to understand the sorption kinetics and determine the mechanism of liquid penetration. Experimental

molar percentage uptake (qt) data is typically fitted to sorption isotherm models, such as the Langmuir or Freundlich models, using Matlab for validation.

1.1 Transport Sorption of Solvents through Fabric Composites

The study of sorption of fabric composites is of high importance since most swollen fabric composites had decreased properties. In commercial applications and in the area of chemical production processes, it is important that these polymers and composites remain chemically stable while retaining their mechanical properties on contact with solvents. It is as result of this that the basic transport phenomenon plays vital role in engineering and industrial uses of textile and polymers. The sorption interaction between polymer composites and additive components is a vital mechanism of interface layer formation.

Composites are materials for engineering which are obtained by combination of two distinct parts, namely: matrix and additive. They are multiphase materials that combine the properties of their constituents to acquire a unique composite property [1]. The factors which affect composites are the nature of materials, the reinforcement, matrix quality, interface of the filler and synthesis process.

The investigation of reinforcement integration into matrix in order to determine specific functions has been studied [2]. They are usually heterogeneous in nature; created in assembly of two or more components; where the additive is not natural, a compactibiliser is employed to bring about adhesion.

The first composite manufactured could have been the mixture of straw and mud to make bricks which had exhibited compression, tearing and squeezing properties that gave rise to excellent building blocks. It has been observed that if the different materials do not dissolve or blend to each other, they can be separated [3]. Composites with weight saving abilities over aluminum were developed for aircrafts. There are basically two composite types; natural and synthetic. The natural composites are obtained by the combination of natural materials with either textile or polymers as the matrix.

However, some polymers come in nature; hence there are composites in nature such wood which consists of containing lignin-long cellulose fibres. Cellulose is also found in cotton fibres which have no lignin to bind it together and hence is weaker. Lignin and cellulose combine to form much stronger material.

Another natural composite is the human bone which consists of hard but brittle substance called hydroxyapatite (mainly calcium phosphate) and a soft and flexible substance referred as collagen (protein). John Wesley Hyatt had developed a cellulose derivative used commercially in the manufacture of dental plates [4].

On the other hand, synthetic composites are obtained from petroleum sources (hydrocarbons). They are either thermoplastic and thermoset composites, depending of the base matrix used. The first synthetic composite obtained was the fiberglass from macromolecules of silica. The fillers used as additives come in different ways; particulate, unidirectional and/or short strands. In this research work, the fillers were used in particulate forms.

Therefore, particulate reinforced composites are composites whose fillers have roughly equal dimensions. They are used to enhance performance of temperature, resistance to wear, and shrinkage as well as friction reduction.

There had been recent studies on the application of polymer composites in the protection of soft rocks. The basic concepts, principles and requirements of such composites for highway engineering were examined and documented. The relevant theoretical analyses, design and construction were articulated in recent studies [5].

The sorption through polymeric composites at molecular level is a kinetic phenomenon that depends on the materials free volume, segmental mobility of the polymers chain, and the penetrant molecular size. This phenomenon is influenced highly by the nature, morphology, crosslinking density of polymers, temperature, shape, and size of the probe penetrant molecules [6].

The swelling of polymeric materials in aromatic solvent environment is highly essential for certain areas of applications such as controlled release systems [7]. Investigation on the influence penetrant molecular size and structure of composites on the sorption and properties of substituted benzenes through commercial polymeric systems had been carried out [8]. From the curve obtained, there was an observed S shape indicating relaxation effects showing non fickian mode. The effect might have arisen from the delay in response to the developed swollen stresses.

Sorption and diffusion results measured at different temperatures had been found to follow Fickian mechanism [9]. There was reduction in rate of adsorption in relation to rise in crosslinking density. Coefficient of diffusion and solubility of solvents were found to correlate with the molecular weights and dipole moment. They also conducted the examining of the interaction of aromatic solvents with different polymeric systems.

The diffusion coefficients derived vary from the sorption coefficients, implying that different mechanism occurred. The heat and mass transport behaviour of polypropylene based nano-composites and the effects of chemical functionalization of multiwall carbon nanotubes have been reported [10].

The transport phenomenon had been found to be related to the structure of polymers. The sorption rate and magnitude tend to decrease with induced crystallinity at higher temperatures [11]

The mechanical, thermal, and morphological characteristics of epoxy resin composites reinforced using repurposed textiles are examined in this work. This study investigates reusing

textile waste to produce composite materials using sustainable alternatives. This study shows how epoxy resin may be improved by mixing recycled materials with powdered coconut shells. 10% of the total weight, or the powdered coconut shell, was combined with fabric and epoxy resin in a 2:1 ratio with hardener. After the mixture was put into molds, it was given a 72-h cure. Two samples were then ready to be tested for their mechanical, morphological, and thermal characteristics. Tensile, bending, impact, thermogravimetric analysis (TGA), and scanning electron microscopy (SEM) tests were used to evaluate performance. The force obtained in the tensile test was 1236.705 N, the bending test produced 86.76 N, and the impact test produced 3.33 J. The fabric and resin were found to have strong binding by SEM examination, and the TGA investigation indicated a notable heat absorption capability. The study offers insightful information on improving material performance through sustainable methods, which benefits the building, automobile, and aerospace sectors—industries where durability and environmental responsibility are critical [12].

2. Materials and methods

The materials and chemicals used in this research were fabrics (Grey and treated). The chemicals included, epoxy, benzene, toluene, xylene, chlorobenzene, acetone, hydrogen peroxide, cobalt as accelerator and borax. The equipment used were water bath, precision electronic weighing machine, stop watch, refrigerator, beakers and medical gloves.

The fabrics were formulated according ISO standard, 1172:1996 by coating the loom and treated states of cotton, linen, nylon and polyester. The loom state fabrics were treated with hydrogen peroxide and borax for comparison with the finished ones, all in 1x1 weave no. Methyl ethyl ketone peroxide (MEKP) and cobalt were used as catalyst and accelerator used in respectively. 40ml of epoxy was measured out in a beaker and poured into a basin. A syringe was used to measure out 20ml each of cobalt and methyl ethyl ketone peroxide and injected gradually at different points in the basin. This was done to avoid evolution of fumes, flames or possible fire when the accelerator (cobalt) and catalyst (MEKP) come into contact. Homogeneity was achieved by continuous vigorous stirring. The samples were subjected to oven drying at 70°C for 30 minutes to eliminate stickiness of the resultant composites.

The transport of the aromatic solvents, chlorobenzene, and acetone through grey fabric filled epoxy were studied at 18, and 27°C by conventional weight loss experiment. The composites in rectangular sheets measuring 7.30 x 22.30cm with thickness of 0.36cm uniform samples were cut off from the sample and soaked in 40cm^3 of the solvents. The dry weight of the samples was measured and recorded with an electric weighing balance of 0.001g accuracy. The samples of known mass (M_i) were each placed in an equilibrated thermostatic water bath at different temperatures stated above. The samples were withdrawn at different time intervals, the solvents adhering to their

surfaces was removed with the aid of the filter paper, weighed and returned to the reagent bottles. The increases in mass with time (M_t) of the swollen samples were recorded. This process was repeated for the different samples until a state of equilibrium adsorption was reached at which time, the weights of the samples remained steady. The results obtained were carefully taken and recorded accordingly. The readings were tabulated and the difference between the dry sample and the wet sample were obtained.

3. Results and Discussion

3.1. Results of Molar Uptake Rate

The experimental results of Molar Uptake Rate obtained by Thermogravimetric Analysis are presented in Table 1 to Table 32. The data from the experiment were subjected to curve fitting to generate equations from the best fit considering the important parameters of coefficient of regression (closest to 1) and root mean square values (Closer to zero).

Table 1. Values of Mass rates of epoxy coated cotton Fabrics in chlorobenzene at 18°**C.**

Time (s)	EC(g)	ECH (g)	ECB (g)	ECHB (g)
0	0.285	0.336	0.482	0.491
600	0.290	0.362	0.467	0.450
1200	0.294	0.371	0.474	0.453
1800	0.296	0.377	0.460	0.457
2400	0.298	0.3386	0.464	0.462
3000	0.299	0.390	0.471	0.466
3600	0.302	0.397	0.476	0.470
4200	0.302	0.397	0.476	0.470

Table 2. Values of Mass rates of epoxy coated cotton Fabrics in chlorobenzene at 27°C

Time (s)	EC (g)	ECH (g)	ECB (g)	ECHB (g)
0	0.612	0.357	0.405	0.257
600	0.626	0.394	0.415	0.294
1200	0.623	0303	0.415	0.303
1800	0.643	0.305	0.418	0.305
2400	0.587	0.302	0.423	0.302
3000	0.587	0.302	0.423	0.302

Table 3. Values of Mass rates of epoxy coated Polyester Fabrics in chlorobenzene at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.064	0.272	0.415	0.405
600	0.0127	0.286	0.402	0.434
1200	0.0190	0.289	0.393	0.453
1800	0.0349	0.296	0.397	0.492
2400	0.0349	0.296	0.397	0.492

Table 4. Values of Mass rates of epoxy coated Polyester Fabrics in chlorobenzeneat 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.064	0.272	0.415	0.405
600	0.0127	0.286	0.402	0.434
1200	0.0190	0.289	0.393	0.453
1800	0.0349	0.296	0.397	0.492
2400	0.0349	0.296	0.397	0.492

Table 5. Values of Mass rates of epoxy coated Linen Fabrics in chlorobenzene at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.064	0.272	0.415	0.405
600	0.0127	0.286	0.402	0.434
1200	0.0190	0.289	0.393	0.453
1800	0.0349	0.296	0.397	0.492
2400	0.0349	0.296	0.397	0.492

Table 6. Values of Mass rates of epoxy coated Linen Fabrics in chlorobenzene at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.064	0.272	0.415	0.405
600	0.0127	0.286	0.402	0.434
1200	0.0190	0.289	0.393	0.453
1800	0.0349	0.296	0.397	0.492
2400	0.0349	0.296	0.397	0.492

Table 7. Values of Mass rates of epoxy coated Nylon Fabrics in chlorobenzene at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.6064	0.5272	0.4151	0.4054
600	0.6127	0.5286	0.4022	0.4343
1200	0.6190	0.5289	0.3933	0.4532
1800	0.6349	0.5296	0.3974	0.4921
2400	0.6349	0.5296	0.3975	0.4920

Table 8. Values of Mass rates of epoxy coated Nylon Fabrics in chlorobenzene at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	GPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 9. Values of Mass rates of Toluene on Cotton at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	GPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 10. Values of Mass rates of epoxy coated cotton Fabrics in toluene at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 11. Values of Mass rates of epoxy coated Polyester Fabrics in toluene at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 12. Values of Mass rates of epoxy coated Polyester Fabrics in toluene at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 13. Values of Mass rates of epoxy coated Linen Fabrics in toluene at 18°C

Time (s)	EP(g)	ELH(g)	ELB (g)	ELHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 14. Values of Mass rates of epoxy coated Linen Fabrics in toluene at 27°C

Time (s)	EL(g)	ELH(g)	ELB (g)	ELHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 15. Values of Mass rates of epoxy coated linen Fabrics in toluene at 18°C

Time (s)	EP(g)	ENH(g)	ENB (g)	ENHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 16. Values of Mass rates of epoxy coated linen Nylon Fabrics in toluene at 27°C

Time (s)	EP(g)	ENH(g)	ENB (g)	ENHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 17. Values of Mass rates of epoxy coated cotton Fabrics in toluene at 18°C

Time (s)	EC (g)	ECH(g)	ECB (g)	ECHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 18. Values of Mass rates of epoxy coated cotton Fabrics in xylene at 27°C

Time (s)	EC (g)	ECH(g)	ECB (g)	ECHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 19. Values of Mass rates of epoxy coated Polyester Fabrics in xylene at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0.7064	0.672	0.415	0.405
600	0.7127	0.686	0.402	0.434
1200	0.7190	0.689	0.393	0.453
1800	0.7349	0.696	0.397	0.492
2400	0.7349	0.696	0.397	0.492

Table 20. Values of Mass rates of epoxy coated Polyester Fabrics in xylene at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
600	0.7064	0.672	0.415	0.405
1200	0.7127	0.686	0.402	0.434
1800	0.7190	0.689	0.393	0.453
2400	0.7349	0.696	0.397	0.492
3000	0.7349	0.696	0.397	0.492

Table 21. Values of Mass rates of epoxy coated Linen Fabrics in xylene at 18°C

Time (s)	EL (g)	ELH(g)	ELB (g)	ELHB (g)
0	0.7064	0.772	0.515	0.405
600	0.8127	0.786	0.502	0.434
1200	0.8190	0.789	0.593	0.453
1800	0.8349	0.796	0.597	0.492
2400	0.8349	0.796	0.597	0.492

Table 22. Values of Mass rates of epoxy coated Linen Fabrics in xylene at 27°C

Time (s)	EL (g)	ELH(g)	ELB (g)	ELHB (g)
0	0.7064	0.672	0.515	0.405
600	0.8127	0.686	0.502	0.434
1200	0.8190	0.689	0.593	0.453
1800	0.8349	0.696	0.597	0.492
2400	0.8349	0.696	0.597	0.492

Table 23. Values of Mass rates of epoxy coated Nylon Fabrics in xylene at 18°C

Time (s)	EL (g)	ELH(g)	ELB (g)	ELHB (g)
0	0.7064	0.772	0.515	0.405
600	0.6127	0.786	0.502	0.434
1200	0.5190	0.789	0.593	0.453
1800	0.4349	0.796	0.597	0.492
2400	0.4349	0.796	0.597	0.492

Table 24. Values of Mass rates of epoxy coated Nylon Fabrics in xylene at 27°C

Time (s)	EN(g)	ENH(g)	ENB (g)	ENHB (g)
0	0.7064	0.772	0.515	0.405
600	0.6127	0.786	0.502	0.434
1200	0.5190	0.789	0.593	0.453
1800	0.4349	0.796	0.597	0.492
2400	0.4349	0.796	0.597	0.492

Table 25. Values of Mass rates of epoxy coated cotton Fabrics in xylene at 18°C

Time (s)	EN(g)	ENH(g)	ENB (g)	ENHB (g)
0	0.0170	0. 385	0. 202	0. 102
600	0.0410	0.403	0. 204	0. 104
1200	0.0460	0.404	0.207	0.107
1800	0.0511	0.400	0. 206	0. 106
2400	0.0511	0. 395	0. 206	0. 106
3000	0.0511	0. 390	0. 206	0. 106
3600	0.0511	0. 390	0. 206	0. 106

Table 26. Values of Mass rates of epoxy coated cotton Fabrics in xylene at 27°C

Time (s)	EC(g)	ECH(g)	ECB (g)	ECHB (g)
0	0. 265	0. 2030	0. 2840	0. 3880
600	0.0678	0. 2060	0. 2880	0. 3940
1200	0.0933	0. 2110	0. 2900	0. 3970
1800	0.0933	0. 2110	0. 2930	0. 3950
2400	0.0933	0. 2110	0. 2930	0. 3950

Table 27. Values of Mass rates of epoxy coated Polyester Fabrics in acetone at 18°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0. 265	0. 287	0. 256	0. 267
600	0. 272	0. 298	0. 262	0. 286
1200	0. 288	0. 297	0. 276	0. 292
1800	0. 290	0. 287	0. 282	0. 294
2400	0. 290	0. 287	0. 284	0. 294
3000	0. 290	0. 287	0. 284	0. 294

Table 28. Values of Mass rates of epoxy coated Polyester Fabrics in acetone at 27°C

Time (s)	EP(g)	EPH(g)	EPB (g)	EPHB (g)
0	0. 265	0. 277	0. 282	0. 233
600	0. 268	0. 281	0. 286	0. 241
1200	0. 275	0. 285	0. 287	0. 245
1800	0. 277	0. 293	0. 292	0. 247
2400	0. 283	0. 287	0. 293	0. 250
3000	0. 283	0. 287	0. 293	0. 250

Table 29. Values of Mass rates of epoxy coated Linen Fabrics in acetone at 18°C

Time (s)	EL(g)	ELH(g)	ELB (g)	ELHB (g)
0	0. 465	0. 222	0. 272	0. 306
600	0.434	0. 245	0. 280	0. 311
1200	0.452	0. 252	0. 283	0. 318
1800	0.464	0. 257	0. 209	0. 318
2400	0.492	0. 257	0. 210	0. 325
3000	0.492	0. 257	0. 210	0. 325

Table 30. Values of Mass rates of epoxy coated Linen Fabrics in acetone at 27°C

Time (s)	EL(g)	ELH(g)	ELB (g)	ELHB (g)
0	0. 465	0.181	0.185	0.179
600	0.464	0.186	0.188	0.177
1200	0.462	0.181	0.178	0.174
1800	0.454	0.179	0.171	0.175
2400	0.452	0.174	0.171	0.175
3000	0.452	0.174	0.171	0.175

Table 31. Values of Mass rates of epoxy coated Nylon Fabrics in acetone at 18°C

Time (s)	EN(g)	ENH(g)	ENB (g)	ENHB (g)
0	0. 465	0.189	0.189	0.179
600	0.467	0.186	0.186	0.177
1200	0.462	0.181	0.178	0.174
1800	0.451	0.179	0.175	0.171
2400	0.452	0.171	0.171	0.165
3000	0.452	0.171	0.171	0.165

Table 32. Values of Mass rates of epoxy coated Nylon fabrics in acetone at 27°C

Time (s)	EN(g)	ENH(g)	ENB (g)	GNHB (g)
0	0. 465	0. 389	0. 289	0.179
600	0.461	0. 386	0. 286	0.177
1200	0.452	0. 381	0. 278	0.174
1800	0.451	0. 379	0. 275	0.171
2400	0.452	0. 371	0. 271	0.165
3000	0.452	0. 371	0. 271	0.165

3.2.1 Curve fitting of Epoxy Coated Cotton Fabrics in boron and hydrogen peroxide at 18°C

The control sample, gave the best fit with coefficient of regression, R^2 of 0.9971 and root mean square error of 0.001491. The model and the parameters of the model are given in Eq. 1 and Table 33 respectively.

Linear model Poly5

$$f(x) = -0.002467e^5x^{\wedge} - 0.007792e^4x - 0.001238e^3 + 0.0152e^2x + 0.02942ex*x + 0.03094 \quad (1)$$

Table 33. Goodness of fit of epoxy coated cotton in acetone at 18°C

Parameters	Control	EC	ECH	ECB	ECHB
SSE	0.4366	0.564	0.0018	0.3503	0.3527
R^2	0.9971	0.9905	0.9707	0.9918	0.9904
Adjusted R^2	0.9954	0.9852	0.9414	0.9872	0.9832
RMSE	0.0015	0.0027	0.0051	0.0019	0.0020

3.2.2. Modelling of the data by Curve fitting

The sample gave the best fit with coefficient of regression, R^2 of and root mean square error of 0.9978. The model and the parameters of the model are given in Eq. 2 and Table 34.

Linear model Poly of order 3:

$$f(x) = p1*x^{\wedge}8 + p2*x^{\wedge}7 + p3*x^{\wedge}6 + p4*x^{\wedge}5 + p5*x^{\wedge}4 + p6*x^{\wedge}3 + p7*x^{\wedge}2 + p8*x + p9 \quad (2)$$

p1 = 0.001719, p2 = 0.003596 p3 = -0.007519, p4 = -0.02022 p5 = -0.008063, p6 = 0.01679, p7 =0.03889, p8 = 0.04712, p9 = 0.02748.

Table 34. Goodness of fit of samples of epoxy coated cotton in acetone at 27°C

Parameters	Control	EC	ECH	ECB	ECHB
SSE	0.0017	0.0020	0.0285	0.0330	0.0377
R^2	0.9933	0.9859	0.9978	0.9972	0.9935
Adjusted R^2	0.9892	0.9694	0.9943	0.9927	0.9830
RMSE	0.0046	0.0057	0.0029	0.0031	0.0033

3.2.3. Modelling of the data by Curve fitting

The sample ECB gave the best fit with coefficient of regression, R^2 0.9993 of and root mean square error of 0.001918. The model and the parameters of the model are given in Eq. 3 and Table 34.

Linear model Poly7:

f f(x) = p1*x^7 + p2*x^6 + p3*x^5 + p4*x^4 + p5*x^3 +p6*x^2 + p7*x + p8	(3)

p1 =0.01216, p2 =0.0211, p3 = -0.03492, p4 = -0.04033, p5 = 0.01045, p6 = 0.003906, p7 = 0.0696, p8 = 0.08049.

Table 35. Goodness of fit of epoxy coated Polyester fabric in Chlorobenzene at 18°C

Parameters	EP	EPB	EPH	EPBH
SSE	0.0404	0.0684	0.0002	0.0124
R^2	0.9918	0.9847	0.9907	0.9993
Adjusted R^2	0.9836	0.9770	0.9861	0.9984
RMSE	0.0821	0.0925	0.0050	0.0192

3.2.4 Optimization of the data by Curve fitting of epoxy coated Polyester in chlorobenzene at 27°C

The sample gave the best fit with coefficient of regression, R^2 of and root mean square error of 0.9979. The model and the parameters of the model are given in Eq. 4 and Table 36.

Linear model Poly8:

f(x) = p1*x^8 + p2*x^7 + p3*x^6 + p4*x^5 +p5*x^4 + p6*x^3 + p7*x^2 + p8*x + p9	(4)

p1 = -0.003948, p2 = -0.01036, p3 = 0.01042, p4 = 0.02993, p5 = -0.01991, p6 = -0.03415, p7 = 0.03246, p8 = 0.05015, p9 = 0.1082

Table 36. Goodness of fit of epoxy coated polyester fabrics in chlorobenzene at 27°C

Parameters	Control	EP	EPB	EPH	EPBH
SSE	0.0606	0.0132	0.0370	0.0407	0.0105
R2	0.9835	0.9964	0.9945	0.9979	0.9673
Adjusted R2	0.9800	0.9949	0.9896	0.9960	0.9573
RMSE	0.0658	0.0332	0.0641	0.0259	0.0897

3.2.5 The Sorption of epoxy coated Polyester fabrics in acetone at 18°C

Modelling of the data by curve fitting. Sample EPB has line of best fit with coefficient of regression of 0.9966 and root mean square error of 0.001015. The model equation and corresponding parameters are given in Eq. 5 and Table 37.

Linear model Poly 4:

f(x) = p1*x^4 + p2*x^3 + p3*x^2 + p4*x + p5	(5)

p1 = -5.506e-06 p2 = 0.0001871 p3 = -0.001855 p4 = 0.008911 p5 = - 1.193e-05

Table 37. Goodness of fit of epoxy coated polyester fabrics in acetone solvent at 18°C.

Parameters	Control	EPC	EPCB	EPCH	EPCBH
SSE	0.0287	0.0090	0.0101	0.0517	0.0120
R^2	0.9864	0.9966	0.9821	0.986	0.9965
Adjusted R^2	0.9769	0.9955	0.9766	0.9783	0.9946
RMSE	0.0021	0.0010	0.0028	0.0026	0.0013

3.2.6 Sorption of Epoxy Polyester Fabrics in acetone at 27°C

Sample LPBH has line of best fit with coefficient of regression of 0.9977 and root mean square error of 0.00362. The model equation and corresponding parameters are given in Eq. 6 and Table 38.

Linear model Poly3:

$$f(x) = 1.07e^{6}x - 5.257e^{5}x + 0.001029e^{4}x - 0.01022e^{3}x + 0.0542e^{2}x - 0.144ex + 0.1552e + 6.573 \quad (6)$$

Table 38. Goodness of fit of Polyester fabrics in acetone at 27°C

Parameters	Control	EP	EPB	EPH	EPBH
SSE	0.06539	0.0442	0.0133	0.0323	0.0131
R^2	0.9962	0.9832	0.9967	0.9933	0.9977
Adjusted R^2	0.9941	0.9741	0.9944	0.9905	0.9961
RMSE	0.0297	0.0634	0.0037	0.0519	0.0362

3.2.7 Modelling of the Sorption of epoxy coated cotton Fabrics in chlorobenzene at 18°C by curve fitting with Matlab

Sample ECB has line of best fit with coefficient of regression of 0.9984 and root mean square error of 0.00363. The model equation and corresponding parameters are given in Eq. 7 and Table 39.

Linear model Poly7:

$$f(x) = 1.33e^{7}x - 7.185e^{6}x + 0.00157e^{5}x - 0.01763e^{4}x + 0.1058e^{3}x + 0.3135e^{2}x + 0.3595ex - 4.081e^{7} \quad (7)$$

Table 39. Goodness of fit of epoxy coated Cotton in Chlorobenzene at 18°C

Parameters	Control	EC	ECB	ECH	ECBH
SSE	0.0445	0.0022	0.0013	0.0011	0.0067
R^2	0.9984	0.9944	0.9984	0.9833	0.9828
Adjusted R^2	0.9973	0.9927	0.9972	0.9763	0.9756
RMSE	0.0257	0.0407	0.0363	0.0969	0.0745

3.2.8 Curve fitting of The sorption of linen in chlorobenzene uptake (%q_e) solvent at18°C by Curve fitting with Matlab

Sample ECBH has the best line of fit. The parameters of the curve fitting is given in Table 40 and Eq. 8.

Linear model:

$$f(x) = 3.187e^{6}x - 0.0001542e^{4}x + 0.0002651e^{2}x - 0.02024e^{2}x + 0?07161x - 0.05473 \quad (8)$$

Table 40. Goodness of fit of epoxy coated linen in Chlorobenzene at 18°C

Parameters	Control	EC	ECB	ECH	ECBH
SSE	0.0017	0.0223	0.0256	0.0092	0.0127
R^2	0.9236	0.9958	0.9860	0.9928	0.9887
Adjusted R^2	0.8664	0.9941	0.9836	0.9899	0.9824
RMSE	0.0046	0.0095	0.0178	0.0117	0.0145

3.3 Curve fitting of the Sorption (%q_e) of Linen in Chlorobenzene at 27 °C

Sample ELB has line of best fit with coefficient of regression, R^2 as 0.9823 and root mean square error of 0.01036. The model equation and parameters are are given in Eq. 9 and Table 41.

Linear model Poly6:

$$f(x) = 7.868e^{6}x - 0.0002893e^{5}x + 0.003978e^{4}x - 0.0255e^{3}x + 0.0786e^{2}x\text{^} - 0.0911x - 1.068e^{6} \quad (9)$$

Table 41. Goodness of fit of epoxy coated Linen in Chlorobenzene at 27°C

Parameters	Control	EL	ELB	ELH	ELBH
SSE	0.0055	0.0050	0.0097	0.0031	0.0012
R^2	0.9833	0.9414	0.9823	0.9583	0.9759
Adjusted R^2	0.9807	0.9323	0.9705	0.9375	0.9672
RMSE	0.0065	0.0197	0.0104	0.0176	0.0105

3.3.1 Curve fitting of the sorption (%q_e) of epoxy coated linen fabrics in acetone at 18 °C

Sample ELH has the best line of fit with coefficient of regression, R^2 as 0.9914 and root mean square error of 0.001725. The model equation and parameters are are given in Eq. 10 and Table 42.

Linear model Poly7:

$$ff(x) = 0.003234e^{7}x + 0.003327e^{6}x\text{^} - 0.01519e^{5}x - 0.01085e^{4}x + 0.01854e^{3}x + 0.008305e^{2}x\text{^} + 0.01012x + 0.3893. \quad (10)$$

Table 42. Goodness of fit of epoxy coated Linen fabrics in Acetone at 18°C

Parameters	Control	EL	ELB	ELB	ELBH
SSE	0.0109	0.0284	0.0367	0.0160	0.0226
R^2	0.9691	0.9830	0.9821	0.9914	0.9911
Adjusted R^2	0.9485	0.9768	0.9665	0.9840	0.9852
RMSE	0.0348	0.0196	0.0261	0.0173	0.0193

3.3.2 Curve fitting of sorption of epoxy coated nylon in acetone at 27°C

Sample EL has the best line of fit with coefficient of regression, R^2 as 0.9986 and root mean square error of 0.0013. The model equation and parameters are are given in Eq. 11 and Table 43.

Linear model Poly 3:

$$f(x) = -0.00326e^{7}x - 0.002476e^{6}x\text{^} + 0.01892e^{5}x + 0.009009e^{4}x\text{^} - 0.0393e^{3}x - 0?01381e^{2}x + 0.05129*x + 0.05254 \quad (11)$$

Table 43. Goodness of fit of epoxy coated nylon at **27°C**

Parameters	Control	EN	ENB	ENH	ENBH
SSE	0.0021	0.0099	0.0019	0.0433	0.0128
R^2	0.9139	0.9986	0.9904	0.9970	0.9950
Adjusted R^2	0.8923	0.9974	0.9841	0.9950	0.9906
RMSE	0.0041	0.0135	0.0463	0.0267	0.0399

3.3.3 Curve fitting of sorption of acetone through epoxy coated Nylon Fabrics at 27°C

Sample ENB has the best line of fit with the following analysis of variance. The model equation and parameters are are given in Eq. 12 and Table 44.

Linear model Poly of order 3:

$$f(x) = -0.003675e^{7}x\text{^} - 0.01027e^{6}x\text{^} + 0.009905e^{5}x + 0.4018e^{4}x - 0.009521e^{3}x - 0.06372e^{2}x\text{^} + 0.04513x + 0.1506 \quad (12)$$

Table 44. Goodness of fit of Epoxy coated nylon Fabrics at 27°C

Parameters	Control	EN	ENB	ENH	ENBH
SSE	0.0264	0.0305	0.0153	0.0189	0.0127
R^2	0.9909	0.9866	0.9954	0.9724	0.9799
Adjusted R^2	0.9877	0.9776	0.9913	0.9586	0.9699
RMSE	0.0049	0.0582	0.0437	0.0109	0.0113

3.3.4 Modelling of Sorption of chlorobenzene through Epoxy coated nylon Fabrics at 18°C by curve fitting

Sample ENH has the best line of fit with the following parameters in Eq. 13 and Table 45.

Linear model Poly 2:

$$f\ f(x) = 1.07e^{6}x - 6.724e^{5}x + 0.00135e^{3} - 0.01126e^{2}x + 0.04286x - 0.02143. \quad (13)$$

Table 45. Goodness of fit of epoxy coated nylon in Chlorobenzene at 18°C

Parameters	Control	EN	ENB	ENH	ENBH
SSE	0.0317	0.0096	0.0117	0.0069	0.0262
R^2	0.9931	0.9964	0.9947	0.9968	0.9878
Adjusted R^2	0.9908	0.9948	0.9930	0.9954	0.9850
RMSE	0.0198	0.0114	0.0120	0.0096	0.0173

3.3.4 Curve fitting the Sorption of chlorobenzene through Epoxy Fabrics at 27°C

Sample ENH has the best line of fit with coefficient of regression, R^2 as 0.9984 and root mean square error of 0.00101. The model equation and parameters are are given in Eq. 14 and Table 46.

Linear model Poly:

$$f(x) = 1.479e5x - 7.038e^{4}x - 0.008363e^{3}x + 0.02839e^{2}x + 9.125ex \quad (14)$$

Table 46. Goodness of fit of epoxy coated nylon

Parameters	Control	EN	ENB	ENH	ENBH
SSE	0.0210	0.0509	0.0082	0.0332	0.0491
R^2	0.9958	0.9889	0.9984	0.9963	0.9935
Adjusted R^2	0.9940	0.9843	0.9977	0.9936	0.9899
RMSE	0.0016	0.0025	0.0010	0.0022	0.0026

4. Conclusions

The modeling of the transport behaviour of epoxy coated fabrics through some selected solvents was carried out to generate equations that produced values that were compared with established isotherms which enabled the sorption properties to be determined without using analytical techniques. The equations followed the polynomial curves indicative of normal Langmuir curves. The best curve was chosen and from it, It was evident that the transport mechanism of most of the samples followed non-Fickian mode of transport (inconsistency in the process was observed). Finally, from the results above, it is evident that the epoxy filled fabrics had good resistance to solvents in the temperatures studied and therefore very good in the storage of chemicals in the laboratory and chemical industries because of low solvent sorption. However, the nylon fabrics had severe cracks with the chemical treatment.

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