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Synthesis, Characterization, and Applications of Anticorrosion Polyurethane Coating: The Effect of Bisphenol F

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Abstract. Polyurethane coatings were synthesized through polyaddition polymerization using various polyols. These polyols included polypropylene glycol with different molecular weights, such as PPG-2000, and PPG-1200, as well as 1,4- butanediol. Additionally different contents of bisphenol F; namely 4.5, 11.5, and 24.2%, as well as methylene diphenyl diisocyanate at an NCO/OH ratio of 2.0. The prepolymer polyurethane films were analyzed to study their characteristics using techniques such as Fourier transform infrared spectroscopy, viscosity measurements, thixotropic index analysis, and mechanical property evaluations. The pot life and dry times of polyurethane coating containing 11.5% bisphenol F were 90 minutes and 10 hours (time to touch), respectively, with full hardening achieved at 28 hours. Furthermore, the coating exhibited excellent mechanical properties: tensile strength of 80 N/m^2, elongation of 260%, adhesion strength of 10 MPa (cross-hatch), hardness of 95, and a contact angle of 118°. These properties, coupled with its strong adhesion (10 MPa) to metal surfaces, contributed to its outstanding chemical and corrosion resistance. The coatings obtained from the prepolymer polyurethane based on 11.5% bisphenol F exhibited the highest mechanical properties and water, chemical, and corrosion resistance followed by 4.5%, and 24.2%, respectively.

Keywords: Bisphenol F; Coating; Corrosion; Polyurethane; Resistance

1. Introduction

Currently, corrosion of metallic buildings is a major global issue, and reducing corrosion losses has become one of the most significant challenges in industrialized countries since these losses are expected to be extremely costly. One of the most effective corrosion prevention strategies is to protect metals using paint and polymer coatings, which have been used effectively for many years and are still being utilized for anticorrosion protection of metallic structures (Petrunin, 2022). Metal materials are commonly utilized for

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engineering and equipment in power systems, ensuring their safety and stability. However, metal material problems, inadequate protection, corrosion fatigue, wear and deformation, and other factors might pose significant hidden risks to power operation. The most prevalent types of damage include fracture, deformation, wear, and corrosion (Huang *et al.,* 2021).

However, it is well known that the strength and durability of adhesion bonds at the metal/polymer interface play an important role in determining the protective qualities of polymer coatings. As a result, another major science and technology goal is the development of ways to increase the adhesive properties of protective covering (Petrunin *et al.,* 2021).

Polymers are widely used for their superior mechanical qualities, resistance to organic and inorganic solvents, and corrosion resistance (Arrieta, Barrera, and Mendoza, 2022; Bekbayeva *et al.,* 2022; Sun, You, and Teo, 2022). Polyurethane prepolymers (PUAs) are widely used in different industrial applications including coating, paint, waterproofing, concrete, anticorrosion, and wear resistance (Kaur *et al.,* 2022; Patil *et al.,* 2021; Negim *et al.,* 2020; Xiang *et al.,* 2020; Alam *et al.,* 2014; Tathe and Jagtap, 2014; Chaudhari *et al.,* 2013; Petrović *et al.,* 2013; Akintayo, Akintayo, and Ziegler, 2011). The latter is attributed to its excellent mechanical characteristics, weatherability, corrosion resistance, and adhesion (Liu *et al.,* 2021).

A number of researchers have investigated different designs for the polyurethane backbone based on the polymerization process, polyols, and isocyanates to achieve high-performance anticorrosion coatings and good mechanical properties (Das and Mahanwar, 2020; Zhang, Tu, and Dai, 2012). PUAs are formed through the polyaddition of polyols and isocyanates. Polyols are crucial for enhancing adhesion strength and flexibility in coatings, whereas isocyanates contribute significantly to improving their mechanical properties (Negim *et al.,* 2020; Akindoyo *et al.,* 2016; Alagi *et al.,* 2016). Furthermore, PUAs with urethane linkages exhibit improved adhesion, abrasion resistance, hardness, and corrosion resistance (Akindoyo *et al.,* 2016). Additionally, the polyol ratio can affect the surface smoothness, contact angle, and crystallinity of PUAs (Negim *et al.,* 2020) are different kinds of isocyanates are classified into aliphatic and aromatic isocyanates. However, PUAs prepared from aromatic isocyanates are more rigid and less expensive than those prepared from aliphatic isocyanates (Negim *et al.,* 2024; Asriyanti *et al.,* 2022; Xu *et al.,* 2012).

Literature review reveals that Ismail, Motawie, and Sadek, (2011) prepared a polyurethane coating using polyols derived from soybean oil, glycerol, and phthalic anhydride at ratios of 20%, 40%, and 60%, respectively. Diphenylmethane diisocyanate was also used in the preparation process. The findings demonstrated an improvement in the coatings' mechanical, physical, and chemical qualities as well as their anticorrosive qualities (Serekpayeva *et al.,* 2022). Tayde, Thorat, and Sonawane (2017) and Harjono, Sugita, and Mas'ud (2012) demonstrated that *castor* oil or jatropha oil could be developed as a raw material for polyurethane coatings, respectively. This behavior is associated with improved film strength and higher resistance to chemicals due to the higher hydroxy content in the castor oil as well as higher crosslinking density. However, a lower hydroxyl content results in greater film elasticity. By using polyols prepared from castor oil and ethanol amine in the preparation of the prepolymer polyurethane, Patil (2019) showed that polyurethane coatings have a long-term protective effect on metal corrosion. On the other hand, bisphenol A (Figure 1) is utilized as a chain extender for the production of polyurethane due to its high oxidation stability, and the two side methyl groups of bisphenol A hinder the crystallization of the hard segments (Xiang *et al.,* 2020).

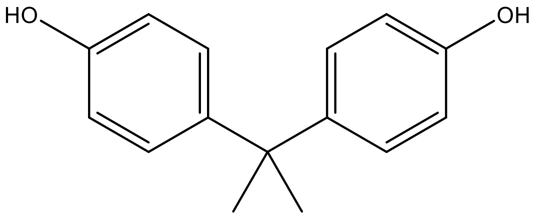

Figure 1 Chemical Structure of Bisphenol A

The hyperbranched polyester polyols used for polyurethane coating provide excellent mechanical strength, chemical resistance, and thermal stability (Abdollahi and Khalili, 2024; Patil, 2018; Elsaid, Badr, and Selim, 2013). In a study by Patil (2019), it was demonstrated that polyurethane coatings based on polyol derived from castor oil and diethanol amine provide long-lasting corrosion protection for metal surfaces in the preparation of prepolymer polyurethanes. On the other hand, bisphenol A used as a chain extender for the production of polyurethane due to the high oxidation stability, and two side methyl groups of bisphenol A hinder the crystallization of the hard segments (Xiang *et al.,* 2020). The hyper-branched polyester polyols for polyurethane coating provide excellent mechanical strength, chemical resistance, and thermal stability (Abdollahi and Khalili, 2024).

This work investigates the development of prepolymer polyurethane coatings by reacting to four different polyols namely, PPG-2000, PPG-1200, and 1,4- butanediol, with different contents of bisphenol F and diphenylmethane diisocyanate (aromatic polyisocyanate) at NCO/OH ratio of 2. The obtained prepolymer polyurethane was characterized by FTIR and physicomechanical tests. The prepolymer polyurethane coatings were applied to mild steel panels and cured at room temperature. The pot life, hardness, impact resistance, flexibility, mechanical properties, adhesion properties, and chemical/corrosion resistance were investigated and measured utilizing standard methods.

2. Experimental

2.1. Materials

Polypropylene glycol (PPG, M_w = 2000 g/mol, OH number = 56 mg KOH/g, Korea PTG, Korea), polypropylene glycol (PPG, M_w = 1200 g/mol, OH number = 98 mg KOH /g, Korea PTG, Korea), and 1,4 butanediol (1,4-BD, M_w = 90,12 g/mol, OH number = 1245 KOH mg/g, Sigma) were dried and degassed at 80°C, and 1-2 mm Hg for 2 h before use. Dibutyltin dilaurate (DBTDL, Fluka), diphenylmethane diisocyanate (MDI, Bayer AG), bisphenol F (BPF, Sigma), NaCl (10%), NaOH (1 M), HCl (1 M), H_2SO_4 (1 M) and HNO_3 (1 M) were obtained from Aldrich (St. Louis, MO, USA). Acetone, xylene, toluene, benzene, butanol, isopropyl alcohol, chloroform, and cyclohexane were obtained from Fluka (Charlotte, NC, USA). The titanium dioxide pigment used was Tiona-595 (crystal, KSA), the rheological and anti-setting used was SR882 and bntone 27 (Elementis, Malaysia), and the dispersing agent was Troysperse CD1 (Troy Co., Canada).

2.2. Synthesis of the prepolymer polyurethane (PUA)

A 500 mL round-bottom, with a three-necked separable flask with a thermometer, condenser with a drying tube, and a mechanical stirrer was filled with polyols, including PPG-2000, PPG-1200, and 1,4 butanediol (1,4-BD). In an oil bath maintained at a constant temperature, the reaction was conducted in an N_2 atmosphere. The diphenylmethane diisocyanate (MDI) was transferred to the flask, and then the mixture was heated at 95°C for 1 h. Next, bisphenol F (BPF) was added to the mixture, and the di-n-butylamine titration technique (ASTM D 2572) was used to calculate the theoretical NCO value (ASTM, 2019). The reaction then continued at the same temperature, and the samples formed a viscous prepolymer. Figure 2 illustrates the chemical method used to prepare the prepolymer, while Table 1 displays the preparation of samples with various BPF amounts and constant NCO/OH ratio.

Table 1 Feed compositions of the prepolymer polyurethane (PUA) with different contents of polyols

Samples	PUA1		PUA2		PUA3		PUA4	
	Wt (g)	Wt (%)	Wt (g)	Wt (%)	Wt (g)	Wt (%)	Wt (g)	Wt (%)
Polyols, OH								
PPG-2000	12.8	23.2	12.8	28.5	12.8	36.6	12.8	51.4
PPG-1200	38.31	69.9	26.3	58.7	14.31	41.2	2.31	9.3
1,4 BD	3.7	6.9	3.7	8.3	3.7	10.7	3.7	15.1
BPF	0.0	0.0	2.01	4.5	4.0	11.5	6	24.2
Total	54.81	100	44.81	100	34.81	100	24.81	100
Mole of OH (gm/mole)	0.0798		0.0798		0.0798		0.0798	
Isocyanate, NCO								
MDI	39.9		39.9		39.9		39.9	
Mole of NCO (gm/mole)	0.1596		0.1596		0.1596		0.1596	
NCO/OH	2		2		2		2	

Note for abbreviations: 1,4 BD = 1,4 butanediol, BPF = bisphenol F, MDI = diphenylmethane diisocyanate

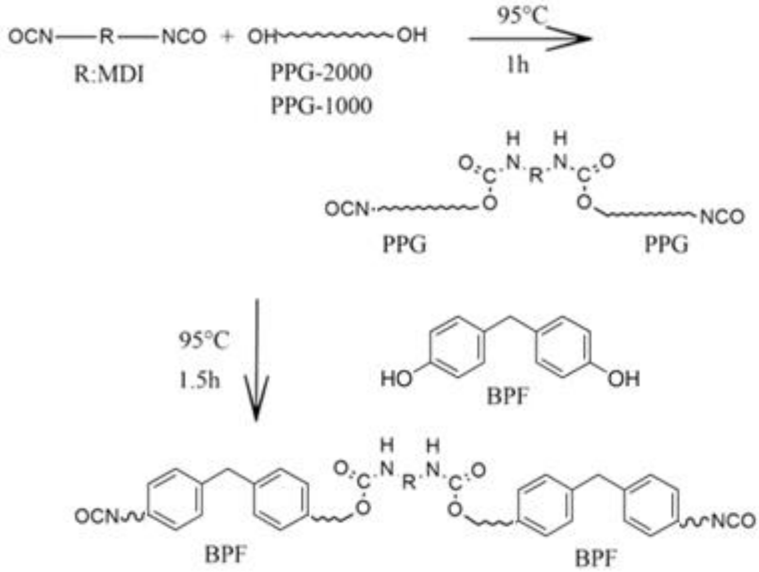

Figure 2 The formation of the prepolymer polyurethane (PUA). Please refer to section 2.2 for the conditions used

2.3. Preparation of polyurethane coatings (PUAC)

Table 2 shows the weight percentages of the ingredients used for the anticorrosion of the polyurethane coatings. The rheological agent, dispersion agent, and anti-setting additives were dispersed in the prepolymer polyurethane (PUA) for 30 minutes at 500 rpm in 2 L of dissolver. Next, titanium dioxide was added to the mixture and mixed for an additional 20 minutes at 1200 rpm. Then, the pigments were gradually added to the mixture and mixed for 30 minutes at 1400 °C for 25 minutes with solvents (xylene and butanol) to adjust the viscosity in the range of 2500 ± 500 cps (Figure 3). Dibutyltin dilaurate (DBTDL) is a catalyst and is added during the application of a coating on a metal.

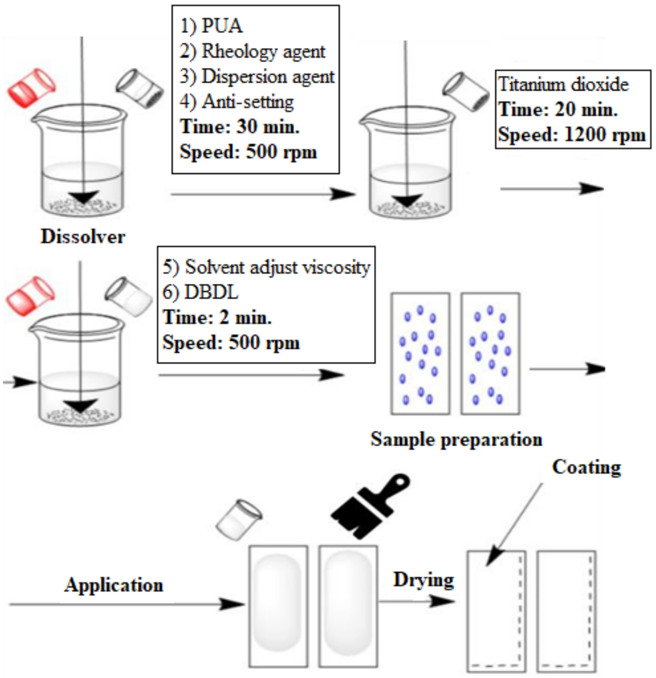

Figure 3 The preparation of the polyurethane coatings (PUAC). Please refer to section 2.3 for the conditions used

Table 2 Anti-corrosion polyurethane coating (PUAC) formulations

Raw materials	Weight percent
Prepolymer PUA	35
Rheological agent	0.5
Titanium dioxide	30
Anti-setting additive	1.5
Dispersion agent	0.03
Pigment	10.22
Xylene	15
Butanol	6
Dibutyltin dilaurate (DBTDL)	1.75

2.4. Film coating preparation

The coating samples polyurethane coatings (PUAC) were applied to mild steel panels (70 mm × 200 mm) according to ASTM D4147-93 and allowed to dry at ambient temperature for 7 days. For further analysis and measurement, the films were kept at room temperature in a desiccator. The thickness of the samples ranged from 70 to 75 μm in the day case and from 80 to 90 μm in the wet case according to Sheen – Ecotest Plus B FN2, type 121-17-00.

2.5. Characterization

The obtained PUA was characterized by ALPHA Fourier transform infrared (FTIR) spectroscopy, (Bruker). FTIR spectroscopy was used to identify the functional groups of PUA (in liquid form). The viscosity (cps) of the epoxy resins and reactive dilutes were measured at room temperature utilizing a Brookfield viscometer according to ISO 12058-1 at speeds of 5 and 50 rpm (in liquid form).

The MTS 10/M tensile testing equipment was used to quantify the tensile characteristics of the PUA and PUAC films, at a crosshead speed of 50 mm/min. A 1-kN load cell was utilized, and an average of at least four measurements was obtained. A CAHN DCA-

322 analyzer running at 25 °C with a water drop at a velocity of 100 lm/s was used to quantify the contact angle that developed between the water droplets and the sample's surface. To evaluate a product's resistance to cracking and/or detachment from a metal substrate after it has been bent around a cylindrical mandrel under typical circumstances, a cylindrical mandrel tester (ASTM D522, 2001) was performed. A tubular impact tester (ASTM D2794, 2019) was used to determine the impact resistance of the film, and an economic cross hatch tester (ASTM D3359, 2001) was used to evaluate the adhesion of the used coatings. For the adhesion strength measurements of the PUA and PUAC, pull-out tests were conducted according to standard methods (En,1542, 1999). The corrosion resistance of the coated panels was tested by salt (10% NaCl), base (1.0 M NaOH), and acid (1.0 M HCl) addition, and a solvent resistance test (ASTM D5402-93) and a water resistance test (D1647-89) were also conducted. During each test, the samples were submerged in their respective solutions for a duration of one week. The purpose of this procedure was to evaluate the corrosion resistance, solvent resistance, and water resistance of the samples. The dry times of the samples were also recorded, and this was done at an ambient temperature of 25°C.

3. Results and Discussion

3.1. *Fourier transform infrared (FTIR) spectrometer analysis*

The FTIR spectrum of the prepolymer polyurethane is depicted in Figure 4. A new peak appeared at 1731 cm^{-1} from carbonyl group stretching as a result of the addition of polymerization between NCO and OH groups. Peaks in the range of 3000–3150 cm^{-1} corresponded to N–H stretching, while peaks at 2969–2922 cm^{-1} were observed for C–H stretching. N–H bending vibrations at 1517 cm^{-1} and absorption band at 1102 cm^{-1} were attributed to C–O–C. Absorption peaks at 1640 and 1454 cm^{-1} correspond to the benzene ring. The peak at 2276 cm^{-1} corresponds to the NCO group, and the intensity of absorption decreased by more than 60% due to the reaction with polyols (OH) during the polyaddition reaction (Nuraini *et al.*, 2017; Zhang, Vennerberg, and Kessler, 2015).

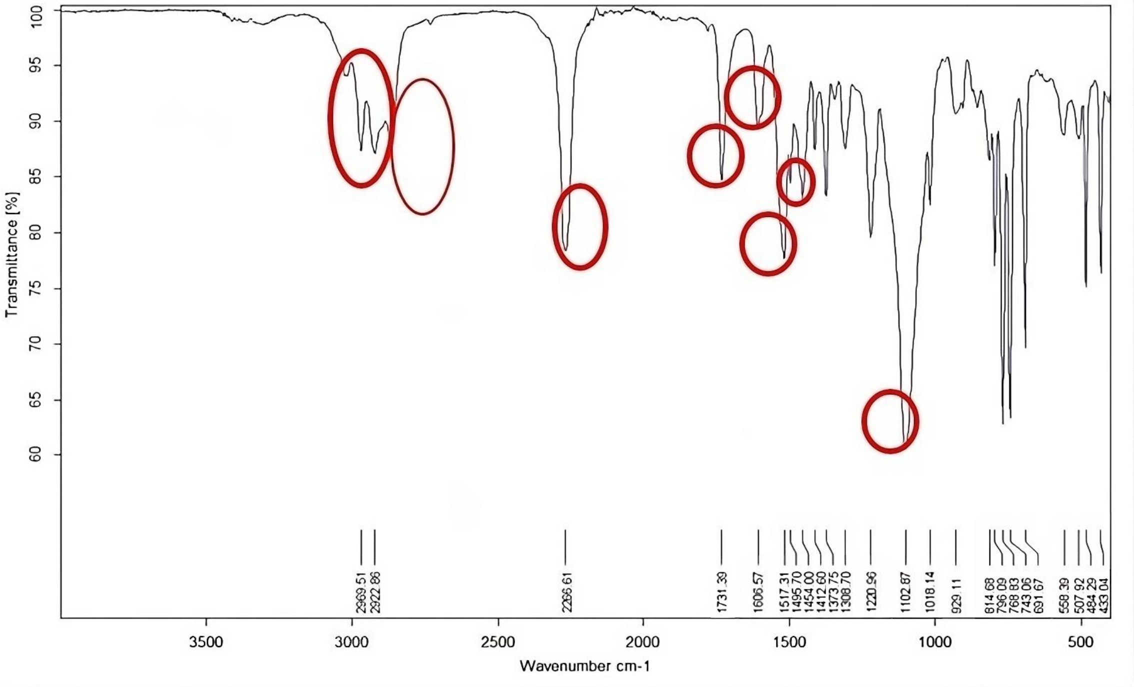

Figure 4 FTIR spectrum of the prepolymer polyurethane (PUA)

3.2. Viscosity

The viscosity of the polymer plays an important role in the application of the polymer in the coating industry (Das *et al.*, 2021). For example, it is difficult to apply a coating at high viscosity, while the sagging problem appears at low viscosity. The effect of BPF content on the thixotropic index (TI) and viscosity of aromatic polyurethane at 5 and 50 rpm is shown in Figure 5. As the bisphenol F content increased from 4.5% to 24.2%, the viscosity of the prepolymer decreased. The viscosity of prepolymer polyurethane containing 0.0% bisphenol F (PUA1) was 15312 mPa-s at 5 rpm and 16440 mPa-s at 50 rpm (thixotropic index = 0.93). The viscosity of prepolymer polyurethane containing 4.5% bisphenol F (PUA2) (4.5% bisphenol F) decreased to 8760 mPa-s at 5 rpm and 10332 mPa-s at 50 rpm (thixotropic index = 0.85). However, prepolymer polyurethane containing 24.2% bisphenol F (PUA4) with a bisphenol content of 24.5% resulted in the lowest viscosity of 850 mPa-s at 50 rpm. The decrease in viscosity is due to the effect of bisphenol F on the soft segment of polyurethane, which is responsible for the polyol backbone (Negim *et al.*, 2024) and in agreement with previously results by Gogoi, Alam, and Niyogi (2013) that viscosity decreases when used polyols based on poly (propylene oxide) glycol. The dependence of the TI on the bisphenol F content is shown in Figure 5. The results showed that the TI increased from 0.93 to 3.4 with an increase in the BPF from 4.5% to 24.2% in the prepolymer polyurethane.

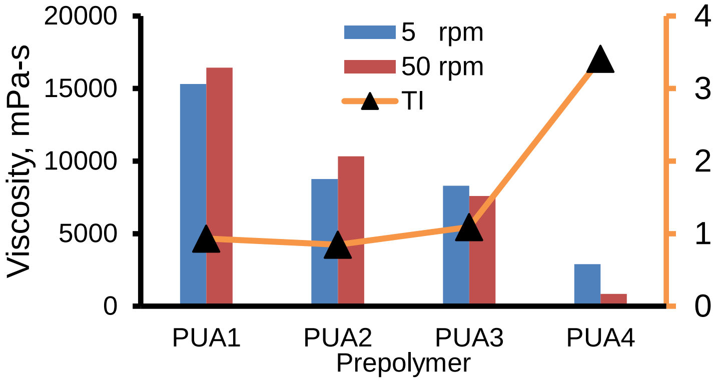

Figure 5 Viscosity and TI of prepolymer polyurethane as a function of BPF

3.3. Mechanical Properties

Table 3 shows that the tensile strength of the prepolymer polyurethane increased as the content of BPF increased from 4.5% to 11.5%, while after 11.5%, the tensile strength decreased. The prepolymer polyurethane, which contained 11.5% bisphenol F (PUA3), demonstrated the highest tensile strength of 78.1 MPa. On the other hand, PUA4 displayed the lowest tensile strength of 29.5 MPa. Notably, these values are higher than the tensile strength obtained from the polyurethane prepolymer that was modified with epoxy and 1,3-propanediol, as reported by (Lutviasari *et al.*, 2017). However, PUA4 had greater elongation at break (140%) than PUA3 (125%), PUA2 (108%) and PUA1 (103%). The effect of BPF content on the hardness and contact angle of the prepolymer polyurethane is presented in Table 1. The contact angle increased as the content of BPF increased from 4.5% to 24.2% while the hardness increased as the content of BPF increased from 4.5% to 11.5%. PUA4 had the highest contact angle (140) and lowest hardness (55), while PUA3 had the highest hardness (98) and PUA1 had the lowest contact angle (103) as in the study reported by authors (Negim *et al.*, 2024). The decrease in the mechanical properties of the prepolymer is attributed to the increase in the number of soft segments in the prepolymer polyurethane upon increasing the BPF content to 24.2% (Rahman *et al.*, 2013).

Table 3 Mechanical properties of the prepolymer polyurethane cast films

	PUA1	PUA2	PUA3	PUA4
Tensile strength (MPa)	32.7	45.9	78.1	29.5
Elongation (%)	170	85	35	25
Hardness (shore A)	65	73	98	55
Contact angle	103	108	125	140

Keynotes to abbreviations: PUA1 = prepolymer polyurethane containing 0.0% bisphenol F, PUA2 = prepolymer polyurethane containing 4.5% bisphenol F, PUA3 = prepolymer polyurethane containing 11.5% bisphenol F, and PUA4 = prepolymer polyurethane containing 24.2% bisphenol F

3.4. Coating properties

3.4.1. Drying time and mechanical properties

Table 4 illustrates how the BPF concentration affects the polyurethane coating's drying and mechanical characteristics. The pot life and dry time of polyurethane coating containing 0.0% bisphenol F (PUAC1) were 90 minutes, 10 h (set to touch), and 28 h (dry hard), while the pot life and dry time of the coating decreased with increasing BPF content from 4.5% to 11.5%.

Table 4 Mechanical, chemical, and corrosion properties of polyurethane coating films

	PUAC1	PUAC2 SECOND BEST 4.5	PUAC3 THE BEST	PUAC4 24.22 THE WORST
Pot life and dry time				
Pot life (25^{o}C, min)	90	65	40	83
Dry time (set to touch), h	10	8	6	11
Dry time (dry hard), h	28	24	20	30
Mechanical properties				
Tensile strength (N/m^2)	50	65	80	45
Elongation (%)	350	300	260	410
Adhesion (MPa)	6	7.5	10	7
Adhesion (cross-hatch), %	100	100	100	100
Impact resistance (1m/ 1kg)	Pass*	Pass*	Pass*	Pass*
Hardness |(Shore D)	75	82	95	60
Conical-Mandrel ¼”)	Pass*	Pass*	Pass*	Pass*
Contact angle	100	110	118	125
Corrosion resistance				
NaCl (10%)	O	O	O	O
NaOH (1 M)	O	O	O	O
HCl (1 M)	X	∆	O	X
H_2SO_4 (1 M)	X	∆	O	X
HNO_3 (1 M)	X	∆	O	X
Water	O	O	O	O
Chemical resistance				
Acetone	∆	O	O	X
Xylene	X	∆	O	X
Toluene	X	∆	O	X
Benzene	X	∆	O	X
Isopropyl alcohol	X	∆	∆	X
Chloroform	X	O	O	X
Cyclohexane	O	O	O	O

Keynotes to abbreviations: O = Suitable, ∆ = Slight Suitable, X = Not Suitable, * = Samples passed the adhesion test (crosshatch), PUAC1 = polyurethane coating containing 0.0% bisphenol F, PUAC2 = polyurethane coating containing 4.5% bisphenol F, PUAC3 = polyurethane coating containing 11.5% bisphenol F, and PUAC4 = polyurethane coating containing 24.2% bisphenol F

However, the highest content of BPF (24.2%) was associated with the longest pot life and dry time than polyurethane coating based on castor oil (Tayde, Thorat, and Sonawane, 2017) and shorter than polyurethane coating made from soybean oil (Ismail, Motawie, and Sadek, 2011).

Moreover, the BPF content increased from 4.5% to 11.5%, leading to an improvement in the mechanical characteristics of the polyurethane coating, such as tensile strength, elongation at break, adhesion hardness, flexibility, and contact angle. The polyurethane coating, which contains 11.5% bisphenol F (PUAC3), exhibited superior mechanical properties compared to the polyurethane coatings with 24.2% bisphenol F (PUAC4), 4.5% bisphenol F (PUAC2), and 0.0% bisphenol F (PUAC1). The increase in the mechanical properties is due to the rigidity of the soft segment from BPF and the hydrogen bonding between the N–H and C=O groups (Negim *et al.,* 2011). Generally, different factors affect the mechanical properties of coatings, including the type of polyurethane, the presence of polyols, the reaction process, and other additives (Kant *et al.,* 2024). The interaction between the polarity of the benzene ring in the BPF and the polarity of the urethane groups resulted in greater adhesion strength in PUAC2, PUAC3, and PUAC4 than in PUAC1. PUAC3 exhibited the highest adhesion (10 MPa), while PUAC1 exhibited the lowest adhesion (6 MPa) which is higher than obtained by the authors (Tayde, Thorat, and Sonawane, 2017; Rahman *et al.,* 2013). However, 100% of all the samples passed the adhesion test (crosshatch). The polyurethane coating films had hydrophobic properties, as indicated by a contact angle greater than 90^{o} (Ma *et al.,* 2023; Rahman *et al*., 2013). The coating films showed good flexibility according to the conical-Mandrel test. This is attributed to the 100% adhesion of all the coating films to the surface, as indicated by the adhesion (pall-off test) and cross-hatching (George, Suraj, and Thomas, 2023). In addition, all the samples had an impact resistance of 1 kg at a height of 1 m, which was accredited to the good adhesion of the coating on the surface of the metal (Mayer, Dmitruk, and Pach, 2018).

3.4.2. Chemical and corrosion resistances

Table 4 shows the chemical and corrosion properties of polyurethane coating films based on different contents of BPF as a polyol in the prepolymer polyurethane. The corrosion results showed that all the samples were unaffected by NaCl (10%), NaOH (1 M), and water. However, acids, including HCl, H_2SO_4, and HNO_3 are not suitable for polyurethane coatings namely, PUAC1 and PUAC4, but are slightly suitable for PUAC2. The PUAC3 showed better acid resistance than the polyurethane coating based on rosin (Abo-Elenien *et al.,* 2014). This can be attributed to the superior mechanical properties of PUA3. The performance of polyurethane coatings depends on the type and content of polyols as well as on the NCO/OH molar ratio (Li *et al.,* 2017; Mishra *et al.,* 2012). The effect of BPF content on the chemical resistance of the coating films is presented in Table 4. All the samples were unaffected by the cyclohexane solvent, but PUAC1 and PUAC4 were affected by all the solvents, except for a slight deterioration in PUAC1 by acetone. However, the chemical resistance of the PUAC3 films is better than that of the PUAC1, PUAC2, and PUAC3 films as well as polyurethane coating derived from polyols based on glycerol, phthalic anhydride, and oleic acid (Velayutham *et al.,* 2009). There was a slight deterioration in PUAC3 and PUAC2 in response to isopropyl alcohol.

In summary, the polyurethane prepolymers based on PUA3 as a polyol exhibited superior physical and mechanical properties compared to those derived from 4.5% and 24.2% BPF because of hydrogen bonds formed by the interactions that contribute to the dipolar nature of the benzene rings from BPF and MDI, as well as between C=O and N–H (Paez-Amieva and Martín-Martínez, 2024). Additionally, because the polyurethane coating (10 MPa) adhered to the metal surface very well, it demonstrated outstanding mechanical qualities as well as resistance to chemicals and corrosion. This polyurethane coating was based on the PUA3 (Alshabebi *et al.,* 2024).

4. Conclusions

Polyurethane polymers were prepared by polyaddition polymerization, using various polyols such as PPG-2000 and PPG-1200, along with different amounts of bisphenol F (4.5%, 11.5%, and 24.2%), and diphenylmethane diisocyanate. The NCO/OH ratio used for the polymerization process was 2.0. The obtained polyurethane prepolymers based on 11.5% bisphenol F as a polyol exhibited better physical and mechanical properties than did 4.5% and 24.2% bisphenol F because of the hydrogen bonds resulting from interactions that contributed to the dipolar nature of the benzene rings from bisphenol F and diphenylmethane diisocyanate as well as between C=O and N–H. Furthermore, a polyurethane coating with an 11.5% bisphenol F content, based on prepolymer polyurethane, demonstrated outstanding mechanical properties, as well as excellent chemical and corrosion resistance. This can be attributed to the coating's exceptional adhesion (10 MPa) to the metal surface. Future studies should focus on understanding the durability of Bisphenol F-containing anticorrosion polyurethane (PU) coatings, investigating their long-term stability under various environmental conditions, examining the mechanisms of aging and deterioration, and exploring the development of eco-friendly, sustainable PU coatings using bio-based raw ingredients. The future study aims to explore the recycling and reusing of PU coatings with Bisphenol F to promote sustainability and reduce environmental impact. It also assesses the toxicity and environmental impact of these coatings to ensure they meet safety standards and regulations. Future research can enhance their performance, expand their use in anticorrosion and high-performance coatings.

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Conflicts of interest

The authors declare no conflict of interest.

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