


PEO poly(ethylene oxide)

| PARAMETER | UNIT | VALUE | REFERENCES |
|--|-----------------------------------|---|---|
| GENERAL | | | |
| Common name | - | poly(ethylene oxide), poly(ethylene glycol) | |
| IUPAC name | - | poly(ethylene oxide) | |
| ACS name | - | poly(oxy-1,2-ethanediyl), alpha-hydro-omega-hydroxy- | |
| Acronym | - | PEO; PEG | |
| CAS number | - | 25322-68-3 | |
| RTECS number | - | TQ3500000; TQ3520000; TQ3560000; TQ3580000; TQ3600000; TQ3610000; TQ3620000; TQ3630000; TQ3650000; TQ3675000; TQ3700000; TQ3800000; TQ3850000; TQ4025000; TQ4026000; TQ4027000; TQ4028000; TQ4030000; TQ4040000; TQ4041000; TQ4050000; TQ4070000; TQ4100000; TQ4105000; TQ4110000; TQ4950000; TQ5090000 | |
| Linear formula | | $\text{H}-\left[\text{OCH}_2\text{CHO}\right]_n-\text{H}$ | |
| HISTORY | | | |
| Person to discover | - | Schoeller, C; Wittwer, M | Schoeller, C; Wittwer, M, US Patent n1,970,578, IG Farber, Aug. 21, 1934. |
| Date | - | 1934 (application in Germany in 1930) | |
| SYNTHESIS | | | |
| Monomer(s) structure | - |  | |
| Monomer(s) CAS number(s) | - | 75-21-8 | |
| Monomer(s) molecular weight(s) | dalton, g/mol, amu | 44.05 | |
| Monomer ratio | - | 100% | |
| Method of synthesis | - | ethylene glycols are used in synthesis because they form polymers of low polydispersity. Anionic polymerization is used more frequently as it produces polymers of low polydispersity. | |
| Number average molecular weight, M_n | dalton, g/mol, amu | 120-136,000 | |
| Mass average molecular weight, M_w | dalton, g/mol, amu | 200-8,000,000 | Wang, H; Rren, J; Yan, M, J. Colloid Interface Sci., 354, 160-7, 2011. |
| Polydispersity, M_w/M_n | - | 1.1-1.3 | |
| Molar volume at 298K | cm ³ mol ⁻¹ | calc.=39.9; 34.5 (crystalline); 38.9 (amorphous); exp.=39.2 | |
| Van der Waals volume | cm ³ mol ⁻¹ | 24.2 (crystalline); 24.2 (amorphous); exp.=25.11 | |
| Radius of gyration | nm | 38-187 | Sung, J H; Lee, D C; Park, H J, Polymer, 48, 4205-12, 2007. |
| End-to-end distance of unperturbed polymer chain | nm | 6-15 | Li, T; Park, K, Computational Theor. Polym. Sci., 11, 133-42, 2001. |
| Chain-end groups | - | OH | |
| STRUCTURE | | | |
| Crystalline structure | | | |

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| Crystallinity | % | 70-82 | Narh, K A; Khanolkar, M; Umbrajkar, S M; Dreizin, E, Antec, 1776-80, 2007. |
| Cell type (lattice) | - | monoclinic | |
| Cell dimensions | nm | a:b:c=0.795-0.805:1.299-1.34:1.925-1.95 | |
| Unit cell angles | degree | β =124.6-126.9 | |
| Number of chains per unit cell | - | 4 | |
| Crystallite size | nm | 6.8 | Slusarczyk, C, Radiation Phys. Chem., in press, 2011. |
| Chain conformation | - | helix 7/2, planar zigzag 2/1 | |
| Entanglement molecular weight | dalton, g/mol, amu | calc.=1,718; exp.=2,200 | |
| Lamellae thickness | nm | 6.8 | Slusarczyk, C, Radiation Phys. Chem., in press, 2011. |
| Avrami constants, k/n | - | 0.0442/1.8 | Qiu, Z; Ikehara, T; Nishi, T, Polymer, 44, 3101-6, 2003. |
| PHYSICAL PROPERTIES | | | |
| Density at 20°C | g cm ⁻³ | 1.1-1.7 | |
| Color | - | clear or white | |
| Refractive index, 20°C | - | calc.=1.4418-1.4468; exp.=1.4563-1.510 | |
| Odor | - | mild | |
| Melting temperature, DSC | °C | -23 to 12; PEG 400=4-8; PEG 600=20-25; PEG 1500=44-48; PEG 4000=54-58; PEG 6000=56-63 | |
| Boiling point | °C | >200 | |
| Thermal conductivity, melt | W m ⁻¹ K ⁻¹ | calc.=0.9085; exp.=08583 | |
| Glass transition temperature | °C | calc.=-60; -60 to -70 | |
| Heat of fusion | kJ mol ⁻¹ | 8.0-9.4 | |
| Hildebrand solubility parameter | MPa ^{0.5} | 20.2 | |
| Surface tension | mN m ⁻¹ | calc.=28.2-36.4; exp.=42.9 | |
| Contact angle of water, 20°C | degree | 35-63.0 | |
| Surface free energy | mJ m ⁻² | 43.1 | |
| Speed of sound | m s ⁻¹ | 37.5 | |
| Acoustic impedance | | 2.72 | |
| MECHANICAL & RHEOLOGICAL PROPERTIES | | | |
| Tensile strength | MPa | 11-60; 100-200 (high molecular weight fibers) | |
| Tensile modulus | MPa | 300; 500-1,000 (high molecular weight fibers); 10,000 (theoretical ultimate modulus) | |
| Elongation | % | 30-70 (high molecular weight fibers) | |
| Poisson's ratio | - | calc.=0.439 | |
| CHEMICAL RESISTANCE | | | |
| Alcohols | - | poor | |
| Aliphatic hydrocarbons | - | good | |
| Aromatic hydrocarbons | - | poor | |
| Esters | - | poor | |
| ⊖ solvent, ⊖-temp.=71°C | - | benzene/isooctane=100/48 | |

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| Good solvent | - | alcohols, benzene, cyclohexanone, esters, water (cold) | |
| Non-solvent | - | aliphatic hydrocarbons, ethers, hot water | |
| FLAMMABILITY | | | |
| Ignition temperature | °C | 182-287 | |
| Limiting oxygen index | % O ₂ | 18.5 | |
| BIODEGRADATION | | | |
| Typical biodegradants | - | PEO-dehydrogenase, PEO-aldehyde-dehydrogenase and PEO-carboxylate-dehydrogenase act sequentially to produce terminal carbonyl and carboxyl groups from the terminal units of poly(ether) chains, followed by the release of C ₂ units as glyoxylic acid | |
| TOXICITY | | | |
| NFPA: Health, Flammability, Reactivity rating | - | 0/1/0 | |
| Carcinogenic effect | - | not listed by ACGIH, NIOSH, NTP | |
| TLV, ACGIH | ppm | 10 | |
| Oral rat, LD₅₀ | mg kg ⁻¹ | 28,000 (MW 200); 38,100 (MW 600); 44,200 (MW 1,000); 50,000 (MW 4,000) | |
| ENVIRONMENTAL IMPACT | | | |
| Aquatic toxicity, <i>Fathead minnow</i>, LC₅₀, 48 h | mg l ⁻¹ | >20,000 | |
| Aquatic toxicity, <i>Rainbow trout</i>, LC₅₀, 48 h | mg l ⁻¹ | >20,000 | |
| PROCESSING | | | |
| Typical processing methods | - | coextrusion, compounding, electrospinning (Forcespinning), reacting with other monomers | Sarkar, K; Gomez, C; Zambrano, S; Ramirez, M; de Hoyos, E; Vasquez, H; Lozano, K, Mater. Today, 13, 11, 12-14, 2010. |
| Additives used in final products | - | Fillers: carbon nanotubes, fumed silica, graphite, Fillers: molybdenum disulfide, montmorillonite, nanosilica, titanium dioxide, vanadium oxide; Plasticizers: dioctyl phthalate, ethylene carbonate, polyoxyethylene-sorbitane monolaurate, propylene carbonate, polyethylene and polypropylene glycols, tetraethylene glycol, tetraglyme; Antistatics: polyoxyethylene sorbitan monolaurate, polyoxyethylene glycol, polyoxyethylene octylphenyl ether | |
| Applications | - | controlled release drugs, haircare, nanocomposites, oil exploration, pharmaceutical applications, polyester fibers, polyester resins, polymer electrolytes, polyols, surfactants, switching elements, unsaturated lithium batteries | |
| BLENDS | | | |
| Suitable polymers | - | chitosan, PAA, PCL, PHB, PMMA, PSU, PVC, PVDF-CTFE, PVF-HFP, PVOH, protein, starch | |
| ANALYSIS | | | |
| FTIR (wavenumber-assignment) | cm ⁻¹ /- | CH ₂ – 2640-3080; C-H – 1467, 1359, 1343, 1241, 962; C-O-C – 1061, 1113, 1147 | Kaczmarek, H; Bajer, K; Galka, P; Kotnowska, B, Polym. Deg. Stab., 92, 2058-69, 2007. |

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| x-ray diffraction peaks | degree | 19.46; 23.52 | Kaczmarek, H; Bajer, K; Galka, P; Kotnowska, B, Polym. Deg. Stab., 92, 2058-69, 2007. |
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