

Index

- 3-D Optical surface profile measurement, 310
- Abrasion, 13, 57, 74–77, 79, 81, 388
- Abrasive wear, 12, 31, 74–77, 101, 388, 404
- Additives
 - interface, 38
 - need, 34–35
 - types, 35–37
- Adhesion, 13, 21, 26, 52, 56–59, 61, 63–65, 79, 82, 90, 410
- Adhesive wear, 10–11, 74, 77–86, 89
- Aerodynamic, 2, 120–122, 210, 298–299, 301, 315
- Aerostatic, 115, 120–122, 209–210, 298–299, 309–318
- Animal fats, 30
- Anti-foaming agents, 36
- Anti-oxidant additive, 35, 37–38
- Anti-wear additive, 35–36, 404
- Archard’s model, 80–82, 100–101, 354, 404, 406
- Arithmetic average, 330–331
- Asperity temperatures, 350–351
- Auto-correlation function, 335–336
- Auto-covariance function, 335–336
- Average surface roughness, 328, 337
- Axial ball bearing, 39
- Barus relation, 131–132, 270, 274
- Bearing, 39–40
- Bearing code, 382–383
- Bearing life, 345, 371–372, 378, 386–387
- Bearing profile, 352, 356
- Bearing stiffness, 218, 222, 225–226
- Bearing terminology, 39, 371–374
- Boundary lubricants, 30, 33, 103–106, 120, 340, 343, 345
- Boundary lubrication, 17–18, 34, 52–110, 338–350, 401–402, 406
- Bowden-Tabor theory, 57–59, 61–62
- Bulk modulus, 155
- Burwell and Strang’s wear equation, 100
- Coulomb theory, 57
- Cam, 11, 20, 89, 92–98, 263
- Cam wear analysis, 92–98
- Capillary, 213–215, 251–252, 312–313, 315
- Cavitation, 34, 153–156, 300
- Center line average, 330–331
- Center of pressure, 201–202
- Ceramic and cermet coating, 21, 26
- Chemical adsorption, 104, 339
- Chemisorption, 104, 106, 339–341
- Chemistry, 1–3
- Chocked flow, 311–312, 318
- Circular flat plates, 229–231
- Circular step thrust bearing, 215–219, 226
- Circularity, 351–353
- Classification, 14, 27–29, 53–54, 74–98
- Coefficient of friction, 16, 20–21, 52–55, 59–61, 63–68, 82, 90, 103–104, 123–124, 132, 142–143, 153, 159–161, 163, 165, 168, 177, 262, 340, 348–350, 353, 383
- Composite surface roughness, 18, 160
- Concave contact, 94–95
- Conservation of mass, 135, 317
- Constant flow system, 254
- Constant pressure system, 214
- Contact between two solid cylinders, 263
- Contact between two solid spheres, 263
- Contact stresses, 1, 12–13, 73, 89–90, 93–94, 96, 98, 337, 350–351, 400, 407–410
- Contaminations, 5, 34, 38, 63–65, 85, 210, 300, 386, 388, 410
- Continuity equation, 135–136, 300
- Convex contact, 94, 263

- Corrosive wear, 75, 86–87, 404
- Cylindrical roller bearing, 40–41, 371, 373, 376, 379, 384, 386
- Cylindricity, 351–354
- Damped vibration, 70–72
- Deformation, 73, 75, 78–79, 81, 85, 90–91, 100, 102, 121, 131, 261–264, 266–267, 278, 280, 326, 354, 373, 393–394, 402, 407
- Delamination theory, 102
- Design table, 175
- Detergents, 34–36, 38
- Discretization, 189, 304, 331
- Dispersants, 34–36, 38
- Dry friction, 55–57
- Dry lubrication, 52, 82, 101, 107
- Dynamic load capacity, 378–379, 383, 386
- Dynamic viscosity, 14, 125–126, 159–161, 163, 168, 327, 345, 355
- Effective Young’s modulus, 97
- Elasto-hydrodynamic lubrication, 2, 17–18, 131, 261–288, 383
- Elliptic partial differential equation, 155
- Energy losses, 5, 56, 226–227
- Engine bearing, 228, 237–240
- Engine particle (sand) separator, 89
- Erosive wear, 75, 87–89
- Ertel-Grubin equation, 274–278
- Esters, 27–28, 33, 37, 385
- Extreme pressure lubrication, 27, 34, 44–45, 106
- Fatigue wear, 88–90, 93, 95
- Ferrography, 413–415, 417
- Finite difference method, 159, 224, 278–279
- Fixed pad thrust bearing, 188, 198–200, 207
- Flow rate requirement, 218, 221
- Flow requirement, 215, 225
- Flow through a capillary, 312–313
- Flow through orifice restrictors, 311–312
- Flow through restrictors, 311, 317
- Flow through slot restrictors, 312
- Fluid film lubrication, 2, 107, 120–122, 134, 210
- Fluid mechanics, 1–3, 121, 132
- Fretting wear, 75, 91–92
- Friction, 52–110, 202
- Friction angle, 65
- Friction control, 102–103
- Friction due to deformation, 56–57, 59–61
- Friction factors for seals, 385
- Friction force, 1, 4, 53–59, 61–62, 65–71, 141–142, 175, 177, 188, 202, 347, 390
- Friction instabilities, 54, 68, 70–72
- Friction models, 57, 70
- Friction moment, 123, 384–386
- Friction power loss, 226
- Friction torque, 161, 163, 168, 219, 348
- Full bearings, 169
- Full-Sommerfeld boundary condition, 146–149
- Gaseous lubricants, 19, 34, 120, 300
- Gasket, 4–10
- Gaussian distribution, 334
- Gear, 13, 40, 73, 75, 107–108
- Graphite, 8, 10, 23–27, 36, 58, 371, 410
- Grease, 13–14, 26–30, 34, 38
- Gumbel’s boundary condition, 148, 154
- Half-Sommerfeld boundary condition, 146, 148–150, 152–154, 174, 239
- Height of profile, 330, 333
- Hertz theory, 263–269
- Holm’s wear equation, 100
- Hybrid bearing, 210
- Hybrid hydrostatic bearing, 122, 210
- Hydrodynamic lubrication, 10, 17–18, 34, 41–42, 107, 122–124, 156, 188, 209, 238
- Hydrostatic, 209–248
- Hydrostatic journal bearing, 222–226
- Hydrostatic lubrication, 122, 209–222
- Hyperbolic partial differential equation, 155
- Hysteresis, 56, 384, 393–394
- Ideal gas, 298
- Idealized bearings, 138–153
- Improved method of journal bearing design, 173–177
- Inclined plane tribometer, 65
- Incompressible fluid, 136, 219
- Infinitely long journal bearings, 144–150
- Infinitely long plane fixed sliders, 138–143
- Infinitely long plane pivoted sliders, 143–144
- Jakobsson-Floberg-Olsson equation, 155
- Journal bearing, 11, 153–156
- Journal bearing design, 145, 175
- Journal position, 156, 238
- Junction growth theory, 61–65
- Kinematic viscosity, 125–126, 128
- Knudsen number, 300, 307, 309
- Kurtosis, 334, 350
- Laws, 54–56, 80–81
- Liquid lubricants, 19–20, 29–34, 64, 123, 137, 154, 282, 298, 300, 350, 383, 401–402, 406, 408, 410–412, 418, 420

- Load, 201
- Load angle, 377
- Load carrying capacity. 41, 122, 153, 155, 158–159, 201, 217–218, 221, 225, 230, 232, 236, 298, 305–306, 309, 313, 316, 345–346, 372, 382, 386
- Load dependent friction moment, 384
- Locating journal position, 156
- Lock, 4, 7, 13
- Long static bearing, 173
- Lubricant, 3, 14–17, 64, 72, 78, 80, 86–87, 101, 103–106, 120, 122–126, 129, 138, 210, 213, 223, 228, 297, 307
- Lubricant additives, 3, 34–38, 343, 402, 410
- Lubricant and speed dependent friction moment, 384
- Lubricant
 - classification, 14
 - properties, 18–19, 99, 246
 - selection, 38–39
 - supply, 156–158, 161, 215, 246
 - type, 19–34
 - usage, 34, 39
- Lubricating grooves, 188
- Lubrication
 - application, 14–15
 - basic modes, 17–18
 - definition, 13–15
 - factor, 38, 385
 - mechanism, 2, 10, 17–18
- M.R. Fluid, 77
- Magnetic bearing, 12
- Magnetic recording discs with flying head, 307–309
- Material science, 1–3
- Maximum profile peak height, 328, 330, 333
- Mean free path, 300, 307
- Mean peak spacing, 333
- Measurable wear, 72–73
- Measurement, 4, 17, 65–67, 329, 331–333, 352–354, 418
- Metal-solid lubricants, 22–23
- Micro fatigue, 75
- Micro-cutting, 75
- Micro-fracture, 75
- Mineral oils, 28, 30–34, 104–105, 127, 131–132, 339–340, 411
- Minimum film thickness, 124, 131, 141, 143, 147, 158–161, 163–164, 168, 200, 234, 237, 242, 261, 277–278, 282–284, 287, 300, 327, 354–355
- Mixed lubrication, 11, 18, 326–356
- Multigrade oils, 131
- Multi-pad bearings, 223
- Multi-recess annular thrust bearing, 223
- Multi-recess bearings, 223
- Multi-row roller Bearing, 12
- Naphthenic oils, 31
- Needle roller bearing, 376, 383
- Newton's law of viscosity, 158, 211
- Newtonian, 144–15, 129–130, 134–136, 138, 202
- Non-dimensional minimum film thickness, 160, 193, 283
- Non-Newtonian, 14–15, 130, 228
- Offline monitoring of gears, 412–415
- Oil flow, 38, 155, 188, 204, 240, 242
- Oil hole, 157, 240, 242
- Online monitoring of gears, 418
- Orifice, 213–215, 251–255, 299, 311–313, 315, 318
- Oxide films, 85, 99
- Pad aerodynamic bearings, 301–306
- Paraffinic oils, 31, 35
- Partial bearings, 42
- Partial groove, 157, 240, 242
- Perfluoro polyalky lether, 33
- Perfluoropolyethers, 33
- Petroff's equation, 158–159
- Physical adsorption, 104, 339–340
- Physisorption, 104, 106, 339–340
- Pin on disk tribometer, 66
- Pitting, 11, 73, 92–93, 95, 381, 387–388, 390, 400, 407–409, 418
- Pitting life, 95
- Pneumatic transportation, 88
- Poiseuille flow, 135, 302, 309
- Polyglycols, 33
- Polymer, 7, 21–22, 32, 36–37, 72, 127, 340, 371
- Polytropic gas, 298
- Pour point depressants, 37, 410
- Power loss, 37, 74, 121, 155, 161, 163, 168, 173, 177, 188, 215, 219, 222, 226–227, 241–242, 245, 248, 297, 382
- Power spectral density, 335–336
- Power torque, 161
- Pressure distribution, 42, 134, 147–152, 173–174, 188–201, 215, 217, 221, 223, 230–232, 237, 239, 262, 264–265, 270, 277–278, 280, 308, 315–316
- Pressure-viscosity index, 131
- Profile peak height, 328, 330, 333

- Profile valley depth, 330, 333
Pumping power loss, 226–227
- Rabinowicz’s equation, 75, 77, 99–101
Radial aerostatic bearings, 313–316
Radial ball bearing, 39
Raimondi and Boyd method, 159–173, 177
Rectangular plates, 231–232
Rectangular slot, 210–213
Rectangular thrust bearing, 219–222
Restrictor, 213–214, 223, 251, 309–318
Restrictor pressure, 310, 312–316
Reynolds boundary condition, 150, 154–155
Reynolds’ equation, 133–138, 154–156, 159, 189, 197, 209, 219–220, 227, 234, 262, 269–274, 300–302, 307, 315
Roelands equation, 131–132
Rolling bearings, 21, 27, 40–41, 83, 89–90, 282, 371, 374–377, 382–386, 388
Root mean square, 17–18, 330, 335, 337
Root mean square slope, 335
Root mean square surface roughness, 328
Rowe’s wear equation, 101
- Scoring wear, 78
Scratching, 74–75, 404, 412
Seal dependent friction moment, 385
Seals, 4–5, 9–10, 13, 23, 28, 37, 72, 282, 384–385
Sector pad mesh, 198
Self-adjusting separation, 210
Semi-solid lubricant, 19, 26–29
Shear strain rate, 14
Shear stress, 14, 59, 62–63, 93–94, 96, 125, 129–130, 134, 141, 202, 211, 381, 386, 390–391, 401
Shear thinning, 130, 228
Short static bearing, 173
Silicone, 6, 27–28
Skewness parameter, 334
Sled tribometer, 66
Sliding bearings, 40–41, 120, 326, 371
Solid lubricant, 19–27, 30, 38, 72, 120, 300, 383, 407–408, 410, 412
Solid mechanics, 1–2, 131
Sommerfeld, 146–150, 152–154, 158, 160–161, 163, 168, 174, 236, 239, 327
Specific film thickness, 17, 326–327, 329, 346, 351, 401–403
Spherical rolling element, 41, 371–372, 374, 376, 379–380
Spherical shape, 60
Spur gear, 107, 109, 284, 342, 400–401, 404–406, 413, 418–419
- Spur gears lubrication, 410–412
Squeeze film, 121–122, 138
Squeeze film lubrication, 209–249
Stachowiak & Batchelor, 126
Static friction, 1, 53–55, 68–69
Stick-slip motion, 68–72
Stribeck diagram, 127
Stylus method, 327, 330–333
Surface failures, 14, 407, 412
Surface films, 64, 74, 79, 82, 98–99, 101, 402
Surface roughness, 2, 5, 17–18, 21, 160, 326–332, 334–335, 337–338, 350–351, 356, 401, 403–405, 409–410
Surface topography, 4, 330–336, 350
Swift-Stieber boundary condition, 155
Synthetic oils, 33–34, 131–132
System power loss, 226–227
- Taper roller bearing, 40–41, 281, 373–376, 383
Tapered rolling element, 371, 373, 377, 384
Theories of dry friction, 57–65
Thermal thickening, 297
Thermal thinning, 298
Thickener, 26–27
Three body abrasion, 75–77
Thrust, 187–206
Thrust aerostatic bearings, 313, 316–318
Tilting pad thrust bearing, 188, 200–201
Tomlinson’s theory of molecular attraction, 57
Total acid number, 19, 37, 418
Total base number, 19, 36, 418
Towers experiments, 123–124
Tribology
 definition, 1
 design, 4–9
 history, 3–4
 industry, 10–13
Tribotester, 67
Two body abrasion, 75–77
Tyre-road Interactions, 371, 392–394
- Universal tribometer, 67
- Variable and alternating loads, 232–233
Vegetable oils, 30
Velocity slip, 300
VI improvers, 32
Vibration monitoring, 418
Viscosity, 10–11, 14, 16, 19, 29–30, 32–34, 39, 77, 105, 121–132, 136, 138, 141, 156, 158–163, 175, 188, 192, 196, 198, 202, 211, 214, 223, 227, 236, 241, 270–271, 274, 277, 280, 283, 297–298, 300, 302, 350, 355, 383, 385, 387, 411, 418

Viscosity Index, 31–33, 126–129, 131, 410	Wear analysis, 92–98
Viscosity–pressure, 131–132, 261	Wear classification, 74–92
Viscosity–shear rate, 129–130	Wear coefficient, 405–406
Viscosity–temperature relation, 126–129, 175	Wear debris, 18, 28, 75, 84, 91, 342, 412–419
Viscous friction, 1, 227	Wear prevention, 102–103
Vogel’s equation, 126, 175	Wear rate, 4, 10, 13–14, 21, 25–26, 65, 72, 74–75, 77–
Volume of flow, 212	78, 82, 85–88, 90, 92, 98–102, 107–110, 326,
Volumetric flow rate, 161, 165, 168, 218, 221, 309,	341–343, 345, 354, 400, 404–406, 413, 415
316–317	Wear–mechanism, 74–75, 77, 86
Walther’s equation, 126, 175, 242, 244–245	Weddle’s rule, 174
Wear, 52–110	Window lifting mechanism, 14
Wear theory, 99–102	Zero wear, 72–73, 153, 210