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|  | |  | | --- | | **Simulation of ActuatedBallValve**  **Date: Tuesday, July 5, 2022 Designer: Solidworks**  **Study name: Static 1**  **Analysis type: Static** | | Table of Contents  [Description 1](#_Toc107920132)  [Assumptions 2](#_Toc107920133)  [Model Information 3](#_Toc107920134)  [Study Properties 7](#_Toc107920135)  [Units 8](#_Toc107920136)  [Material Properties 9](#_Toc107920137)  [Loads and Fixtures 10](#_Toc107920138)  [Connector Definitions 10](#_Toc107920139)  [Interaction Information 11](#_Toc107920140)  [Mesh information 11](#_Toc107920141)  [Sensor Details 11](#_Toc107920142)  [Resultant Forces 12](#_Toc107920143)  [Beams 12](#_Toc107920144)  [Study Results 13](#_Toc107920145)  [Conclusion 15](#_Toc107920146)  [Appendix 15](#_Toc107920147) | |
| Description No Data |

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| Assumptions |

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| Model Information  |  |  |  |  |  | | --- | --- | --- | --- | --- | | |  | | --- | |  |   ****Model name:** ActuatedBallValve**  ****Current Configuration:** Default** | | | | | ****Solid Bodies**** | | | | | ****Document Name and Reference**** | ****Treated As**** | ****Volumetric Properties**** | ****Document Path/Date Modified**** | | **Boss-Extrude1** | **Solid Body** | ****Mass:0.000129979 kg****  ****Volume:1.27431e-07 m^3****  ****Density:1,020 kg/m^3****  ****Weight:0.0012738 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\BallValve\BottomWasher.SLDPRT****  **Jun 24 11:33:39 2022** | | **Boss-Extrude3** | **Solid Body** | ****Mass:0.0111655 kg****  ****Volume:9.00443e-06 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.109422 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Interface.SLDPRT****  **Jun 29 16:55:28 2022** | | **CirPattern1** | **Solid Body** | ****Mass:0.0549658 kg****  ****Volume:4.43433e-05 m^3****  ****Density:1,239.55 kg/m^3****  ****Weight:0.538665 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\MotorCage.SLDPRT****  **Jul 4 20:54:35 2022** | | **Chamfer1** | **Solid Body** | ****Mass:0.00680121 kg****  ****Volume:8.83274e-07 m^3****  ****Density:7,700 kg/m^3****  ****Weight:0.0666518 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Nema17StepperMotor\Rotor.SLDPRT****  **Jun 28 17:21:40 2022** | | **Fillet1** | **Solid Body** | ****Mass:0.300319 kg****  ****Volume:3.90025e-05 m^3****  ****Density:7,700 kg/m^3****  ****Weight:2.94313 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Nema17StepperMotor\frontCase.SLDPRT****  **Jun 29 16:55:29 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00193954 kg****  ****Volume:2.51889e-07 m^3****  ****Density:7,699.99 kg/m^3****  ****Weight:0.0190075 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\BallValve\Nut.SLDPRT****  **Jun 24 11:24:37 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.00020699 kg****  ****Volume:1.66927e-07 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0020285 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\Straps Nut.SLDPRT****  **Jun 24 17:08:09 2022** | | **Thread1** | **Solid Body** | ****Mass:0.200546 kg****  ****Volume:2.6045e-05 m^3****  ****Density:7,700 kg/m^3****  ****Weight:1.96535 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\BallValve\ball.SLDPRT****  **Jun 24 11:31:25 2022** | | **Cut-Extrude3** | **Solid Body** | ****Mass:0.647671 kg****  ****Volume:8.41131e-05 m^3****  ****Density:7,700 kg/m^3****  ****Weight:6.34717 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\BallValve\socket.SLDPRT****  **Jun 29 16:59:50 2022** | | **Fillet1** | **Solid Body** | ****Mass:0.00400466 kg****  ****Volume:3.22956e-06 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0392456 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\strap.SLDPRT****  **Jul 5 12:56:44 2022** | | **Fillet1** | **Solid Body** | ****Mass:0.00400466 kg****  ****Volume:3.22956e-06 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0392456 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\strap.SLDPRT****  **Jul 5 12:56:44 2022** | | **Fillet1** | **Solid Body** | ****Mass:0.00400466 kg****  ****Volume:3.22956e-06 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0392456 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\strap.SLDPRT****  **Jul 5 12:56:44 2022** | | **Fillet1** | **Solid Body** | ****Mass:0.00400466 kg****  ****Volume:3.22956e-06 m^3****  ****Density:1,240 kg/m^3****  ****Weight:0.0392456 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\strap.SLDPRT****  **Jul 5 12:56:44 2022** | | **Boss-Extrude1** | **Solid Body** | ****Mass:0.000462512 kg****  ****Volume:6.00665e-08 m^3****  ****Density:7,700 kg/m^3****  ****Weight:0.00453262 N**** | ****B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl\BallValve\topWasher.SLDPRT****  **Jun 24 11:29:45 2022** | |

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| Study Properties  |  |  | | --- | --- | | Study name | Static 1 | | Analysis type | Static | | Mesh type | Solid Mesh | | Thermal Effect: | On | | Thermal option | Include temperature loads | | Zero strain temperature | 298 Kelvin | | Include fluid pressure effects from SOLIDWORKS Flow Simulation | Off | | Solver type | Automatic | | Inplane Effect: | Off | | Soft Spring: | Off | | Inertial Relief: | Off | | Incompatible bonding options | Automatic | | Large displacement | Off | | Compute free body forces | On | | Friction | Off | | Use Adaptive Method: | Off | | Result folder | SOLIDWORKS document (B:\5.1\PROJECT\progress\Synthetic-HdyroExperimental-Machine-Project\designs\DischargeFlowControl) | |

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| Units  |  |  | | --- | --- | | Unit system: | SI (MKS) | | Length/Displacement | mm | | Temperature | Kelvin | | Angular velocity | Rad/sec | | Pressure/Stress | N/m^2 | |

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| Material Properties  |  |  |  | | --- | --- | --- | | ****Model Reference**** | ****Properties**** | ****Components**** | |  | |  |  | | --- | --- | | ****Name:**** | **PLA (1)** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Max von Mises Stress** | | ****Yield strength:**** | **3.5e+07 N/m^2** | | ****Tensile strength:**** | **3e+07 N/m^2** | | ****Elastic modulus:**** | **2e+09 N/m^2** | | ****Poisson's ratio:**** | **0.394** | | ****Mass density:**** | **1,020 kg/m^3** | | ****Shear modulus:**** | **3.189e+08 N/m^2** | | **SolidBody 1(Boss-Extrude1)(BottomWasher-1)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **PLA** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Max von Mises Stress** | | ****Yield strength:**** | **3.5e+07 N/m^2** | | ****Tensile strength:**** | **3e+07 N/m^2** | | ****Elastic modulus:**** | **2e+09 N/m^2** | | ****Poisson's ratio:**** | **0.3** | | ****Mass density:**** | **1,240 kg/m^3** | | ****Shear modulus:**** | **3.189e+08 N/m^2** | | **SolidBody 1(Boss-Extrude3)(Interface-1),**  **SolidBody 1(CirPattern1)(MotorCage-1),**  **SolidBody 1(Thread1)(Straps Nut-1),**  **SolidBody 1(Thread1)(Straps Nut-2),**  **SolidBody 1(Thread1)(Straps Nut-3),**  **SolidBody 1(Thread1)(Straps Nut-4),**  **SolidBody 1(Thread1)(Straps Nut-5),**  **SolidBody 1(Thread1)(Straps Nut-6),**  **SolidBody 1(Thread1)(Straps Nut-7),**  **SolidBody 1(Thread1)(Straps Nut-8),**  **SolidBody 1(Fillet1)(strap-1),**  **SolidBody 1(Fillet1)(strap-2),**  **SolidBody 1(Fillet1)(strap-3),**  **SolidBody 1(Fillet1)(strap-4)** | | **Curve Data:N/A** | | | |  | |  |  | | --- | --- | | ****Name:**** | **Alloy Steel** | | ****Model type:**** | **Linear Elastic Isotropic** | | ****Default failure criterion:**** | **Max von Mises Stress** | | ****Yield strength:**** | **6.20422e+08 N/m^2** | | ****Tensile strength:**** | **7.23826e+08 N/m^2** | | ****Elastic modulus:**** | **2.1e+11 N/m^2** | | ****Poisson's ratio:**** | **0.28** | | ****Mass density:**** | **7,700 kg/m^3** | | ****Shear modulus:**** | **7.9e+10 N/m^2** | | ****Thermal expansion coefficient:**** | **1.3e-05 /Kelvin** | | **SolidBody 1(Chamfer1)(Nema17StepperMotor-1/Rotor-1),**  **SolidBody 1(Fillet1)(Nema17StepperMotor-1/frontCase-1),**  **SolidBody 1(Thread1)(Nut-1),**  **SolidBody 1(Thread1)(ball-1),**  **SolidBody 1(Cut-Extrude3)(socket-1),**  **SolidBody 1(Boss-Extrude1)(topWasher-2)** | | **Curve Data:N/A** | | | |

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| **Loads and Fixtures**  | ****Fixture name**** | ****Fixture Image**** | ****Fixture Details**** | | --- | --- | --- | | **Fixed-1** |  | |  |  | | --- | --- | | Entities: | **4 face(s)** | | Type: | **Fixed Geometry** | | | ****Resultant Forces****   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Components** | **X** | **Y** | **Z** | **Resultant** | | **Reaction force(N)** | **-0.00455375** | **-0.000934992** | **-0.0719149** | **0.072065** | | **Reaction Moment(N.m)** | **0** | **0** | **0** | **0** | | | |  | ****Load name**** | ****Load Image**** | ****Load Details**** | | --- | --- | --- | | **Torque-1** |  | |  |  | | --- | --- | | Entities: | **1 face(s)** | | Type: | **Apply torque** | | Value: | **1.1768 N.m** | | |

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| Connector Definitions No Data |

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| Interaction Information  | Interaction | Interaction Image | Interaction Properties | | --- | --- | --- | | Global Interaction |  | |  |  | | --- | --- | | Type: | **Bonded** | | Components: | **1 component(s)** | | Options: | **Independent mesh** | | |

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| Mesh information  |  |  | | --- | --- | | Mesh type | Solid Mesh | | Mesher Used: | Blended curvature-based mesh | | Jacobian points for High quality mesh | 16 Points | | Maximum element size | 1.29331 cm | | Minimum element size | 0.0646657 cm | | Mesh Quality | High | | Remesh failed parts independently | Off |  Mesh information - Details  |  |  | | --- | --- | | Total Nodes | 316448 | | Total Elements | 194520 | | Maximum Aspect Ratio | 872.66 | | % of elements with Aspect Ratio < 3 | 77.5 | | Percentage of elements with Aspect Ratio > 10 | 6.08 | | Percentage of distorted elements | 0 | | Time to complete mesh(hh;mm;ss): | 00:02:33 | | Computer name: | PROMETHEUS | |

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| Sensor Details No Data |

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| Resultant ForcesReaction forces  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N | -0.00455375 | -0.000934992 | -0.0719149 | 0.072065 |  Reaction Moments  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N.m | 0 | 0 | 0 | 0 | |
| Free body forces  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N | 0.0905526 | -0.100616 | -0.0431123 | 0.142064 |  Free body moments  | Selection set | Units | Sum X | Sum Y | Sum Z | Resultant | | --- | --- | --- | --- | --- | --- | | Entire Model | N.m | 0 | 0 | 0 | 1e-33 | |

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| Beams No Data |

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| Study Results  | Name | Type | Min | Max | | --- | --- | --- | --- | | Stress1 | VON: von Mises Stress | 8.504e-04N/m^2  Node: 2050 | 1.592e+08N/m^2  Node: 215791 | | **ActuatedBallValve-Static 1-Stress-Stress1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Displacement1 | URES: Resultant Displacement | 0.000e+00mm  Node: 4421 | 6.763e-01mm  Node: 4416 | | **ActuatedBallValve-Static 1-Displacement-Displacement1** | | | |  | Name | Type | Min | Max | | --- | --- | --- | --- | | Strain1 | ESTRN: Equivalent Strain | 3.247e-13  Element: 74995 | 5.394e-03  Element: 67208 | | **ActuatedBallValve-Static 1-Strain-Strain1** | | | | |

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| Conclusion |

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| Appendix |