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Throtteling microflow with porous ceramics for the application in implantable infusion pumps

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Introduction

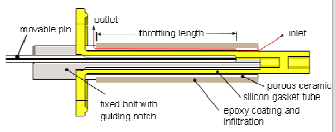
Spontaneous flow changes are not possible in gas driven implantable infusion pumps due to their fixed throttle. Therefore an adjustable throttle model is developed by the mean of porous ceramics based on the patent DE102009022182A1 [1]

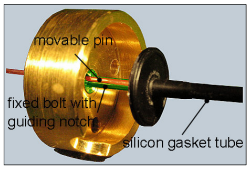
Project requirements

- Flow range 70 – 4000 nl/min
- Flow rate accuracy ± 10 %
- Adjustable to any flow within 10 – 120 s
- Pressure, absolute 3.5 bar

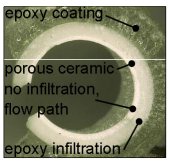
Methods

The throttle model consists of an adjustable flow path through a porous ceramic tube. A special designed silicon gasket tube, in which a pin moves, is used to adjust the sealed length of the ceramic tube. The length of the flow path is proportional to the penetration length of the movable pin in the gasket tube. The pin moves in a guiding notch of a bolt that sticks in the silicon gasket tube to fix it and to seal the ceramic tube on 70 – 80% of its circumference and on its whole length.



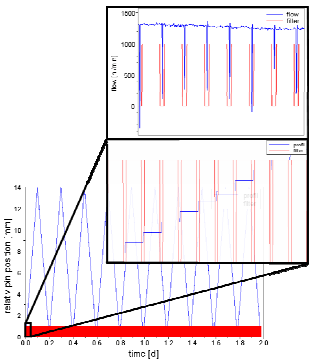


A radial cut through the porous ceramic shows the epoxy coating and infiltration. The ceramic is infiltrated with epoxy for an increased flow resistance.



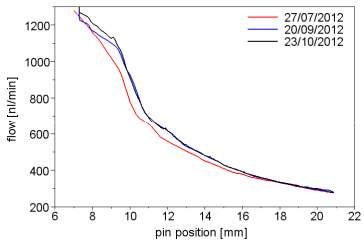
If the throttle pin moves, an additional flow is generated. Therefore the pin is moved step wise. Valid flow values are only available if the pin is at rest. A filter is created to gain valid values. At each pin position step the measured values are averaged and this leads to the characteristic line of the throttle as Q(s).

To get a reliable characteristic line the whole pin hub is repeated ten times and this again after two and three month.

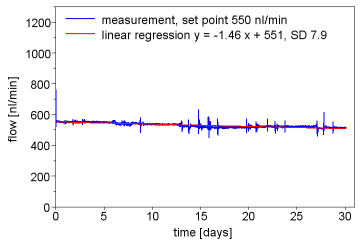


Results

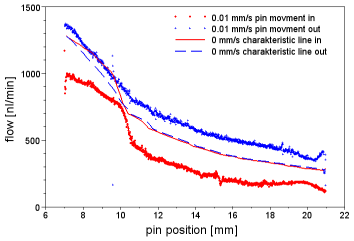
The throttle characteristic line is stable during three months of use. Values between 270 nl/min and 1260 nl/min are gained with this throttle configuration.



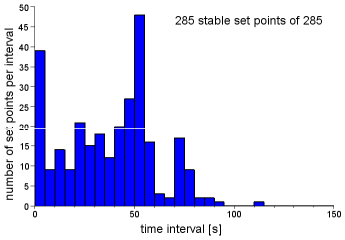
The 30 days measurement shows a decreasing flow of 1.5 nl/min per day. For a flow of 550 nl/min the deviation is less than 0.3 % per day. It could be readjusted by the patient.



The graph shows the increased and decreased flow caused by the pin movement. A volume of 235 nl is shifted by 1 mm pin movement. As a dosing volume it can be neglected.



The histogram shows the distribution of set points which reached stability in a certain time interval.
A demanded flow is actuated within 10 - 113 s by an algorithm that based on the characteristic line of the throttle. The mean value is 38 s.



Conclusion

The developed throttle model has the ability to fulfill the demanded project requirements. It turns out to be stable in its characteristic line and in its long term behavior. A demanded dosing value is reached in a convenient time. Therefore the model is a possible solution to adjust dosing in an implantable infusion pump.

References

[1] University of Applied Sciences Lübeck, Pat. DE 10 2009 022 182 A1, 20.05.2009
[2] H. Jannsen, Realisierung eines Funktionsmodells einer verstellbaren Drossel für Medikamentenpumpen, Masterarbeit, Fachhochschule Lübeck/Universität zu Lübeck, Januar 2013

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GEFÖRDERT VOM
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