

Preliminary design of a disposable multi-position flow valve for an innovative multiple infusions system

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Introduction

Preventable errors in intravenous infusions

- The administration of multiple intravenous (IV) infusions to patients is a complex task with many potential associated patient safety risks[1].
- IV infusion set-ups are a source of dose errors in intensive care units, due to:
 - complexity of IV set-ups to medical staff.
 - hygiene problems that are related to the number of catheters used[2][3].
 - incompatibility reactions between medications[4].



Fig. 1 – Chaos in infusion set-ups creates a vague scene of the devices

Idea

Drug Multiplexing

- To develop a miniaturized model of IV medication delivery station, which integrates syringe pumps into one device.
- The device shall :
 - allow a clear IV set-up scene.
 - lower infection risk, by using one infusion catheter.
 - avoid incompatibility reactions by separating medications via separators.
- The use of a single infusion catheter ensures more mobility, clearer IV set-up scene, and lower risk of infection caused by high number of infusion tubes.
- Separation of mimicked drugs is achieved by using gaseous medium (4.26 $\mu\text{L CO}_2$) as a barrier in catheter[5].

Preliminary design

Disposable multi-position flow valve

- A drug multiplexing test model was designed and constructed, in which segmentations and flow order of drugs are accomplished by using a selector rotary valve.
- As a criterion for hygienic purposes, and for later use in clinical practice, the valve must be disposable.
- Using the valve module as a disposable unit requires suitable material and manufacturing processes for mass production.
- A 5-Way rotary valve was designed and fabricated.
- PCTFE material was used for the valve plug and for the housing that connects the valve operation area.
- The test of the valve without grease showed ineffective sealings between channels.
- In future work, the valve sealing will be tested with bio-compatible fat.

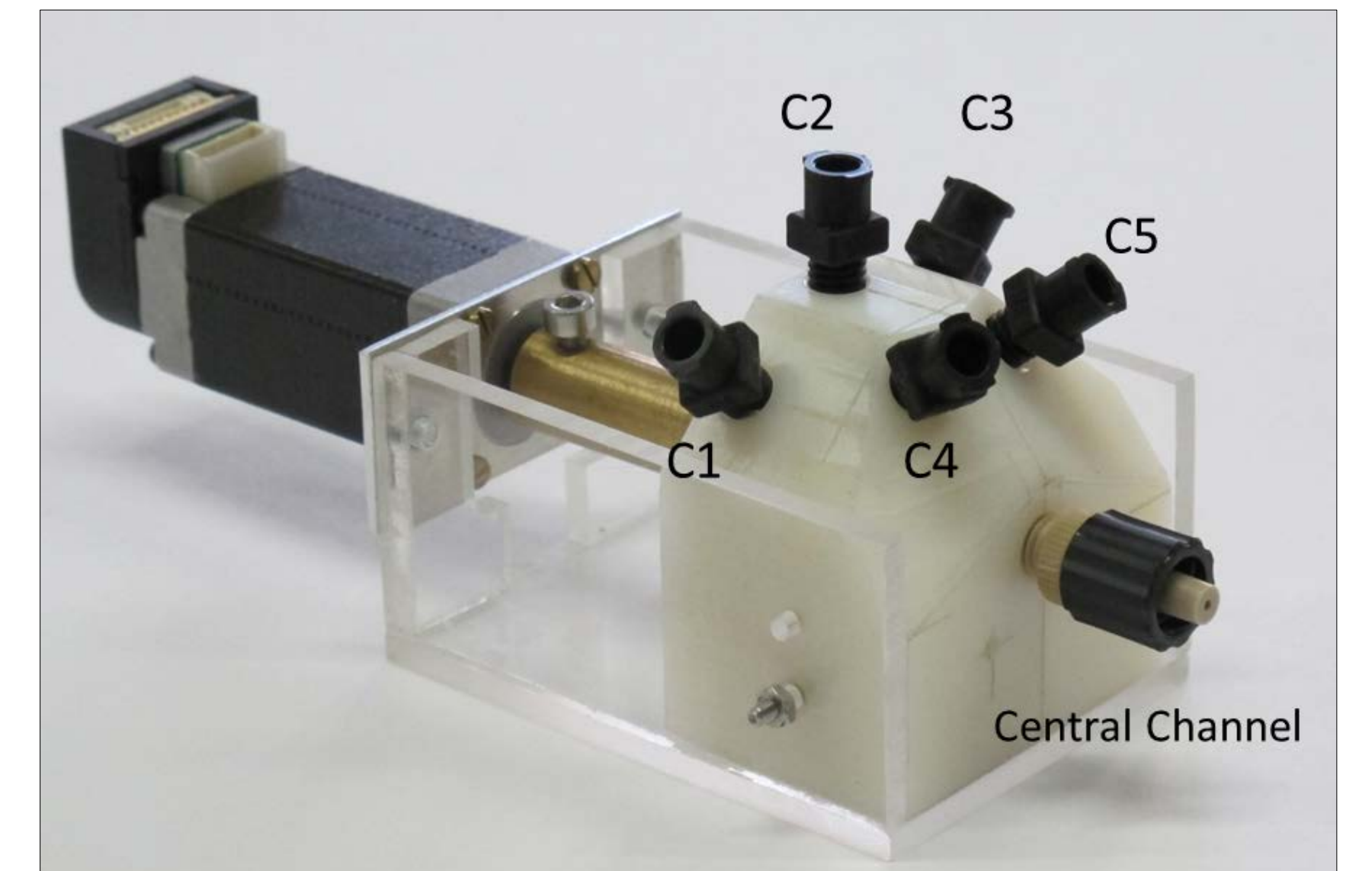


Fig. 2 – The 5-Way rotary valve attached to a stepper motor

Alternative design

Development of IV test model and multi-position valve

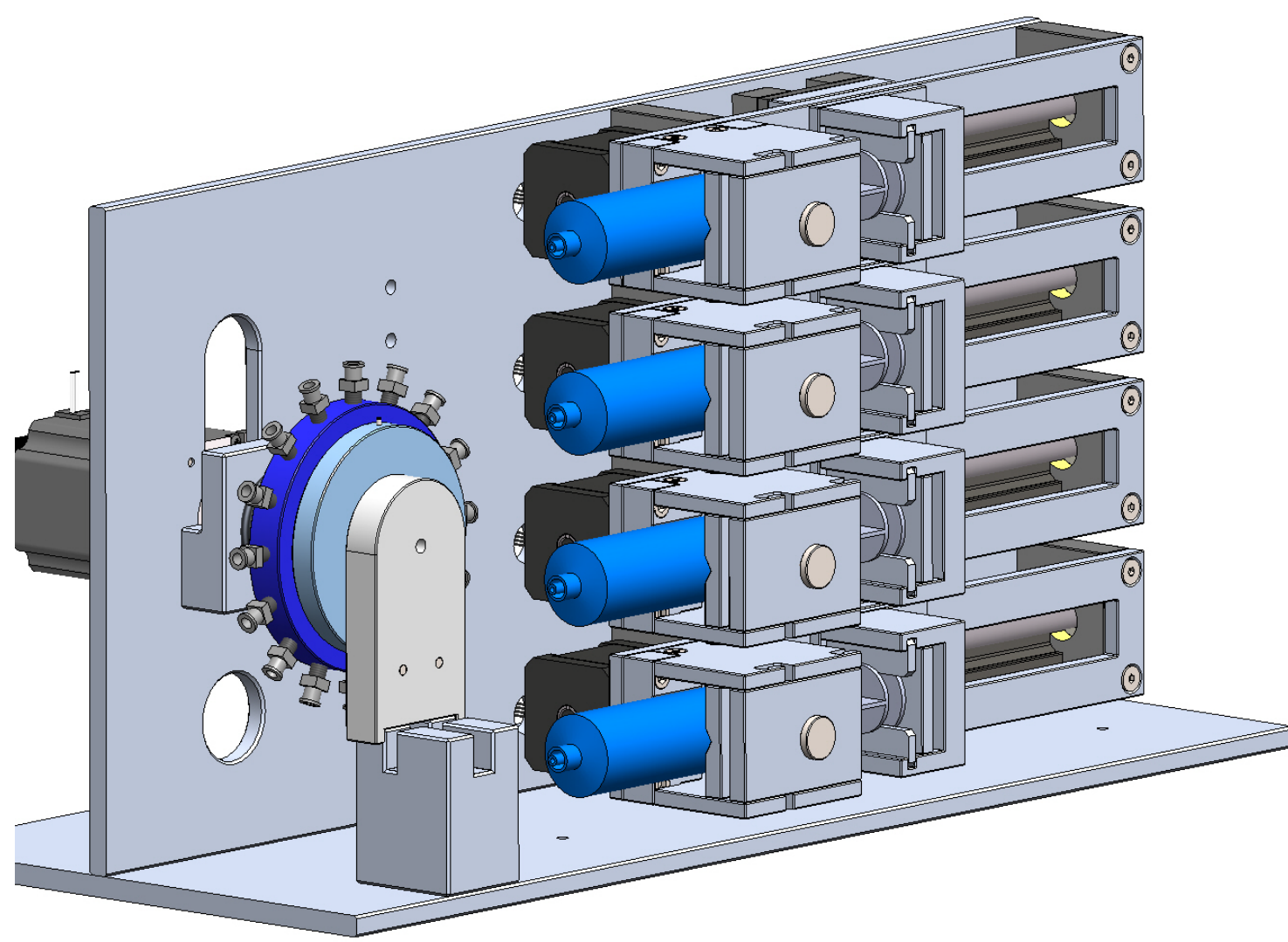


Fig. 3 – Concept design of Drug Multiplexing Infusion System with a central selection valve

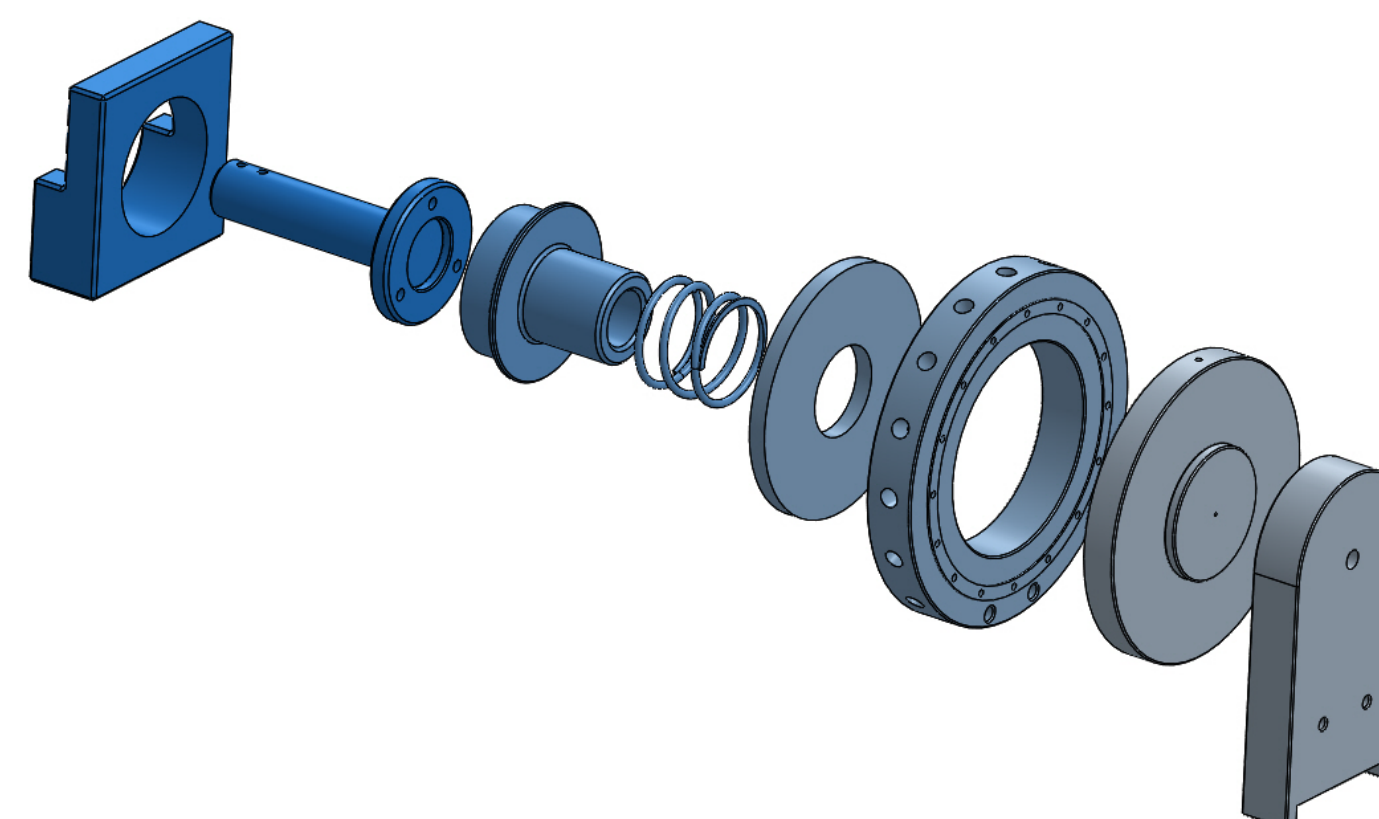


Fig. 4 – Exploded view of the selection valve

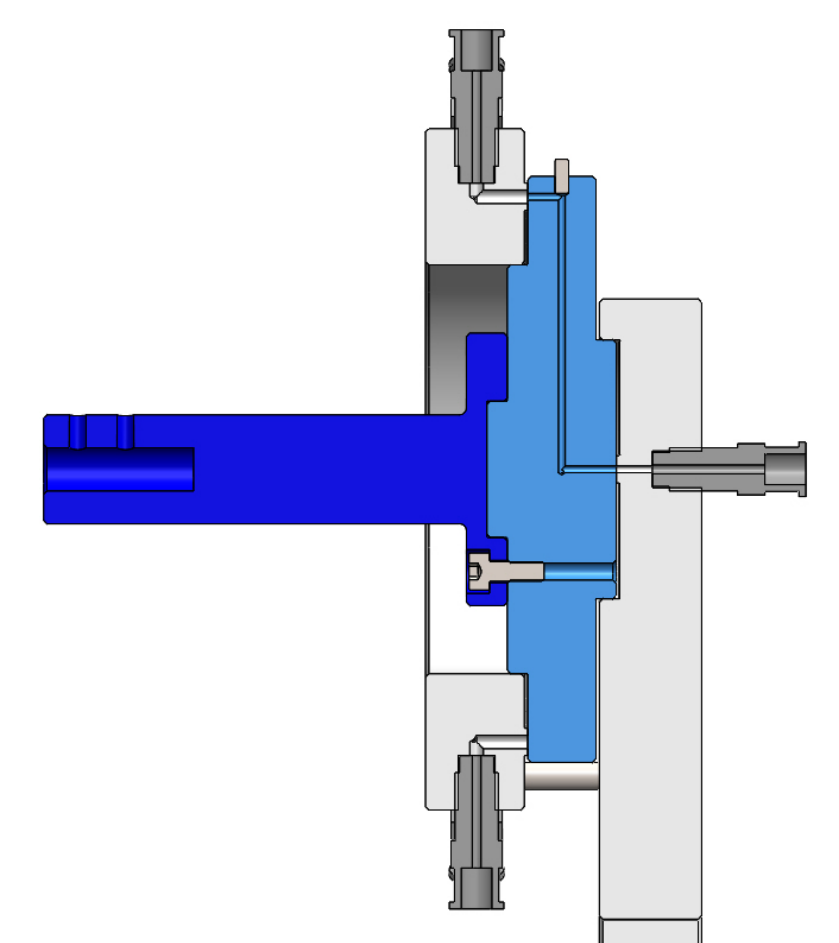


Fig. 5 – A cross– sectional view of the selection valve

- We are looking for a sealing solution which does not require the use of grease.
- This Drug Multiplexing IV model consists of 8 syringe pumps and 8 gas channels, which are switched by a rotary valve.
- While the first valve is based on a conical valve plug, which is difficult for production with high accuracy, the new valve works with a plain sealing area.
- Theoretical calculation of the mounting pressure ensures better dry sealing of valve parts.

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