# CHROMATOGRAPHY COLUMN PACKING METHOD OF VARIABLE SPEED OPERATION

## BACKGROUND OF THE INVENTION

### Field of the Invention

[0001] The present invention relates an apparatus and method of operating a chromatography column and, more particularly, to such a chromatography column and a method for effectively packing media and/or automatically moving the top flow adapter at at least one predetermined speed less than a maximum speed and/or providing at least one programmably set bottom limit stop.

### Description of Related Art

[0002] Chromatography is a process of separating components of a mixture of chemical substances through the percolation of fluid through a body or bed of comminuted or porous rigid material, known as media. In the process, the various component are often resolved, or separated, by their selective retardation as they are transported through the bed by a moving fluid or buffer. A solution of the substances to be separated becomes the moving phase of the system passing through the interstices in the stationary or continuous phase which are finely divided particles, possibly in the form of a gel slurry.

[0003] The substances in the moving phase are normally poured into the top of a chromatography column filled with the finely divided material, i.e., the media, that can absorb differentially the substances to be separated. The particular material used for the media varies widely with the substances to be separated. As the solution percolates down the column the components are separated from the buffer fluid which may be pumped

a hydraulic pump could be varied manually with a regulator on the air supply. However, this process was completely operator dependent and not particularly precise. If left to normal operation with the controller, the only speed of operation was the maximum speed.

**[0006]** The prior art packing technique involved an operator lowering a plunger until it stopped. When lowering the plunger at its single fastest speed, when the liquid in the column was first encountered, the plunger could continue downward at this speed thereby likely continuing to pack the bed. This could lead to an undesirable pack in at least some situations.

[0007] Accordingly, a need exists to improve the operational methods by providing an improved chromatography column.

## SUMMARY OF THE INVENTION

**[0007a]** According to a first aspect of the present invention, there is provided a method of operating a chromatography column comprising the steps of: providing a cylinder with a plunger connected to a drive system configured to provide first and second plunger speeds, said plunger moveable within a cavity of the cylinder in an operational mode, said drive system having at least one driver operably coupled to the plunger, at least one position sensor sensing a position relative to a position of at least one of the driver and the plunger; a controller in communication with the position sensor whereby the plunger initially moving at the first speed is automatically changed from the first speed at a first predetermined elevation corresponding to a position related to at least one of the

driver and the plunger to the second speed by the controller; wherein at least one of the first and second speeds is a speed other than maximum speed and stopped and the second speed is slower than the first speed.

**[0007b]** According to a second aspect of the present invention, there is provided A method of operating a chromatography column comprising the steps of: providing a cylinder with a plunger connected to a drive system, said plunger moveable within a cavity of the cylinder in an operational mode at at least two speeds, first and second speeds, said drive system having at least one driver operably coupled to the plunger, and utilizing a controller in communication with the plunger, moving the plunger at a speed other than maximum speed and stopped as directed by the controller as one of the first and second speeds the first and second speeds are programmably input as preset speeds into the controller with the second speed slower than the first speed, the second speed and occurring at a preset elevation selected by an operator at the controller prior to initiating the first speed, said second speed initiated after the first speed.

**[0008]** Embodiments of ~~T~~the present invention seek to~~recognizes and~~ addresses these needs and others.

**[0009]** ~~Consequently, it is an object of at least one e~~Embodiments of the present invention seek to provide an improved chromatography column and method of its operation.

**[00010]** ~~It is another object of at least one e~~Embodiments of the present invention seek to provide a chromatography column capable of automatically changing plunger speeds according to predetermined settings.

**[00011]** ~~It is another object of at least one e~~Embodiments of the present invention seek to provide a chromatography column with a controller which can move the top flow adapter at least two programmably selected and/or predetermined speeds.

[00012] Accordingly, embodiments of the present invention seek to provides a chromatography column having a cylinder defining a cavity for containing media therein. A top flow adapter or plunger is operatively coupled to a hydraulic piston moveable through at least a portion of the cavity within the cylinder during operation. A base is normally connected to the cylinder. The plunger may be operatively coupled to the hydraulic piston to adjust the height of the plunger above the base to provide a desired resin height between the plunger and the base for operation. The plunger may also be utilized to exert a force on the resin to "pack" the resin in the column.

[00013] A controller is also provided which maypreferably at least assists in providing one of a number of operational capabilities not provided in the prior art. The controller receives an input relative to at least one of three of the hydraulic cylinders utilized in the preferred embodiment relating to at least one of position and/or pressure. These inputs can be utilized to move the top flow adapter relative to the column of at least two predetermined speed settings such as could be set to occur at a particular plunger elevation, to switch to a slower speed upon encountering a predetermined pressure or pressure differential pressure at each of at least some of the pistons, and/or to prevent the top flow adapter from contracting a manual step in such an embodiment.

[00014] The hydraulic system may include preferably includes at least one piston which is driven by at least one hydraulic cylinder. In this the preferred embodiment, a plurality of hydraulic cylinders are utilized which are driven from a common hydraulic pressure source which is coupled to a controller through a proportional servo valve. The controller receives