MARCH 9, 2016

AICHE 2016 STUDENT DESIGN COMPETITION

Cell Therapy for Spinal Cord Injuries: Commercial Manufacturing Facility

Group Number: _____

Table of Contents

Figures

Tables

Abstract

The following contains preliminary design considerations for the large-scale production of neural stem cells for spinal cord injury regeneration therapy. The facility is designed to meet market demand for years 2017-2021 assuming there are currently 250,000 people, plus the addition of 12,000 people each year, with spinal cord injuries. In other words, 66,222 people per year can benefit from this process. Each batch process begins with 100,000 undifferentiated induced pluripotent adult stem cells and ends with approximately 2.17×10^{11} differentiated neural stem cells that have gone through various measures to ensure quality. Each neural stem cell vial contains 1×10^{7} cells and the breakeven price per vial was calculated to be $24.04 at a hurdle rate of 50%. The overall capital cost for the process is $871,606 with maximum recurring costs of about $7,000,000 from media, chemicals, vials, well racks, and operating costs each year.

As can be seen in the "Sensitivity Analysis" section, the selling price of the vial has a major impact on the net present value (NPV) of the project. The cost of the media also can have a major impact on the net present value as it represents a major portion of the recurring costs. Therefore, if media costs go down, the NPV of this project will go up in response.

Three or four operators are required per shift for operation depending upon the part of the process that is occurring. Most of the process is automated and at any given time, there is no more than nine of the nineteen pieces of equipment in operation and four of those are only on for a short amount of time.

Safety considerations were of the utmost importance in designing this process. The facility is designed to minimize cross contamination by separating the sterile process from the rest of the facility. All waste is pretreated before entering city sewers to prevent the spread of possible blood borne pathogens to the community.

It is recommended from the preliminary design that a detailed design be conducted as the project is a low capital investment, has a short payback period, and is very economically attractive as can be seen from the "Conclusions and Recommendations" section of the document.

Introduction

Currently, there is roughly 250,000 people in the United States of America with spinal cord injuries and about 12,000 more occurring each year. The biotechnology company is developing spinal cord injury regeneration therapy to allow the people with these injuries to be mobile again. The team was tasked with designing a new manufacturing facility for this therapy. The production process includes a low shear bioreactor system that maintains control of pH, dissolved oxygen, and temperature. The bioreactor system is designed under cGMP conditions.

The commercialization team has designed a process that has the potential to give 66,222 people per year significant functional recovery, improved quality of life, and reduction of cost of medical care. The process starts with 100,000 adult pluripotent stem cells that are expanded and then differentiated into neural stem cells that can be injected into the injured part of the spine to aid in healing. Neural stem cells are more beneficial than other treatments because, once injected, they have the ability to differentiate into all types of neural cells [1]. Figure 1 below shows the concept of the design.

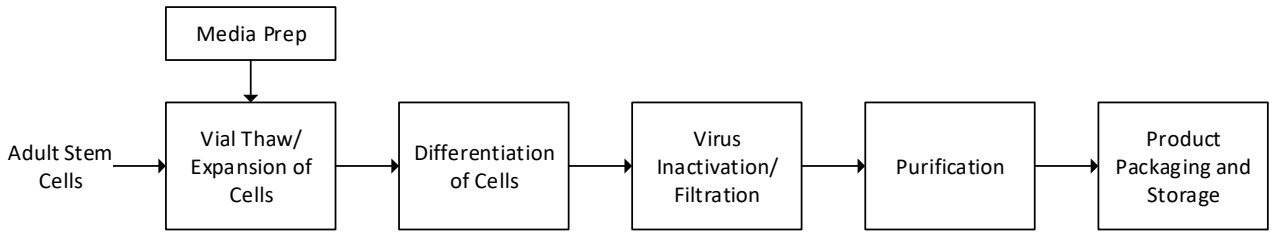

Figure 1. Overview for the Process

This process was designed to be inherently safe. Most vessels have steam in place for automatic sterilization right before each use to maintain a contaminant free environment. Units cleaned with chemicals rather than steam in place have a separate waste disposal system to avoid hazardous chemical interactions. All hazardous chemical interactions were considered in a interaction matrix.

The recommended design should be forwarded to the biotechnology company's management team as soon as possible because time is of the essence. The following report discusses the technical specifications, economics, and gives overall conclusions and recommendations for the manufacturing facility.

Process Flow Diagram and Material Balances

The subsequent pages give a visual representation of the preliminary design for the production of neural stem cells in the manufacturing facility. Figure 2 shows the expansion, differentiation, and sterilization steps of the process while Figure 3 shows the virus filtration, purification, packaging, and storage processes.

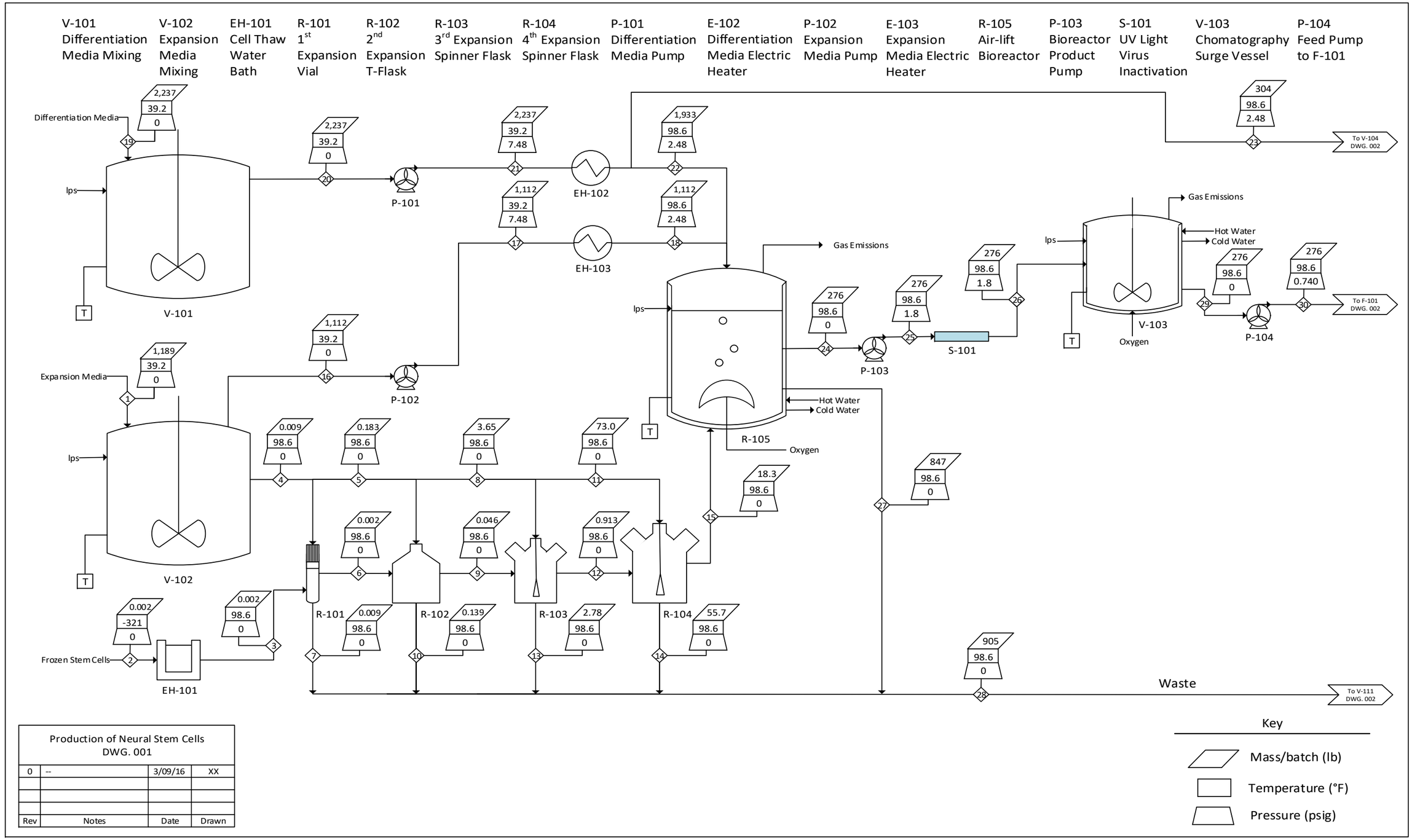

Figure 2. Preliminary Design for Expansion, Differentiation, and Sterilization of Adult Stem Cells

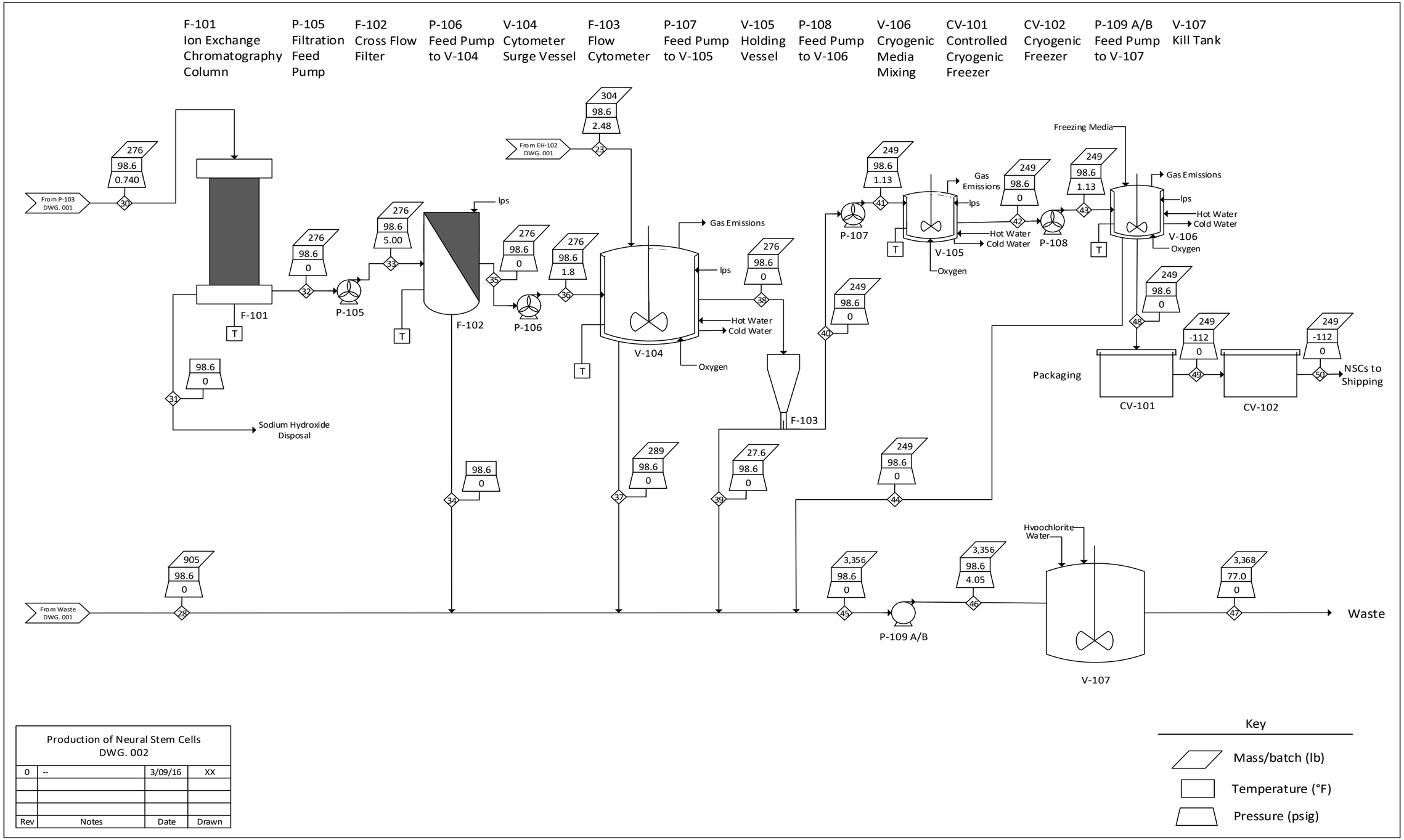

Figure 3. Preliminary Design for Filtration and Packaging of Neural Stem Cells