



Attachment No. 1 to the request for quotation No. 2/A1.4.1/KPO/2023 of 18.10.2023

## USER REQUIREMENT SPECIFICATION - Specification update – 19.10.2023

The subject of the Request for Quotation is the purchase and delivery along with supervision over the installation of a brand new MEMBRANE FILTRATION DEVICE (order No. 1) and an INSULATED TANK min. 10 m<sup>3</sup> (order no. 2) with parameters not worse than those described below and in accordance with the requirements specified below.

### 1. Introduction

The main task of the installation is to separate the stream of raw material (extract – berry juice) due to the size of the particles. Permeate is an aqueous solution of sugars, mainly fructose and glucose ( $M_w = 180$  gram/mol). Retentate is an aqueous fraction rich in polyphenols (including anthocyanins), oligosaccharides and other compounds with a molecular weight of  $> 500$  grams/mol

The organic substances included in the concentrate (retentate) are thermolabile compounds with limited stability and poorly soluble in water in a neutral pH. The optimal conditions for the process are  $T < 20^\circ$  and optimally  $\sim 15^\circ\text{C}$  (mainly due to the high sugar content in the process media, which is associated with the risk of microbial growth) and  $\text{pH} = 2.5 \pm 0.5$ .

The device in question should be designed for continuous operation – "feed and bleed" and made in a fully automated version, taking into account the CIP cleaning process.

The raw material for the device will be berries (e.g. chokeberry, elderberry, haskap berry or forest berry) processed at the Greenvit plant. The method of preparing the feed consists in pouring water with the additives of excipients onto the fruits. The fruits are mixed and heated, after the time indicated by the technology, the liquid extract is separated from the remains of the fruit (solid – pomace). A decanter centrifuge (4000 xg) is used for the separation process. The fruit extract obtained in this way is stored in buffer tanks and after initial control filtration (20 micrometer filters) it is the feed for the Membrane Filtration Device.

The plant extract prepared in this way is not sufficiently clarified to feed the ultrafiltration (separation limit at 500 g/mol), thus there is a need to control microbiological parameters and the need to manage all process streams, the Ordering Party has identified three main components of the Membrane Filtration Device:

- Microfiltration (ceramic membranes with a 0.5  $\mu\text{m}$  cut-off point)
- Ultrafiltration (spiral plastic membranes with a "cut-off" of 500-2000 Da)
- Reverse osmosis

During the separation process, PRODUCT 1 is first produced - UF concentrate (ultrafiltration) rich in organic compounds (polyphenols). PRODUCT 2 – RO (reverse osmosis) concentrate, is a by-product rich in monosaccharides of fruit origin and minor concentration of polyphenols.

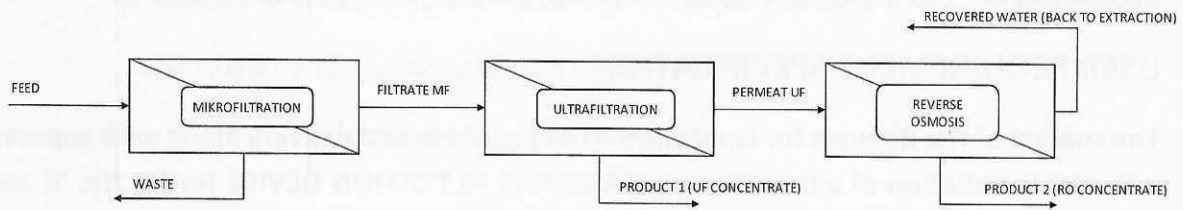


Figure 1. Block diagram of the membrane filtration process

## 2. Execution standard of the Order Items

The appliance must be made to a food standard. All components in contact with the product should be made of steel 1.4404, Ra < 0.8. Components, structures and control cabinet made of 1.4301 or 1.4307 steel. All gaskets are approved for contact with food.

Any connection between product contact elements or hygienic test and measurement equipment connections, perforated DIN 32676 or DIN connectors. 11851/11864. The Contracting Authority allows other hygienic connections if this is dictated by safety issues (e.g. high pressures).

The entire device will work in the production hall (temperature controlled). The utilities necessary for the operation of the device are available in the room (electricity, compressed air, cooling water, chilled water (propylene glycol), steam).

### 2.1. Compliance with food requirements – cGMP (Current Good Manufacturing Practice)

All elements of the Device, including storage tanks, are cleaned in the "clean in place" (CIP) system.

The Ordering Party has at its disposal a storage tank(s) for cleaning agents. The supplier is responsible for the delivery of the CIP+ pump and the output of the track control and routes to all tanks (automated cleaning of storage tanks). The Ordering Party is responsible for the preparation and storage of cleaning agents for ZM1-5 tanks.

Membrane Filtration Device washed in an automatic system (fully automated) equipped with pumps collecting chemicals dedicated to cleaning filtration membranes. In-house preparation system for cleaning agents based on conductivity and temperature measurements.

Additionally, the fundamentals of equipment design will ensure that:

- a. There will be no dead zones or, when technically impossible, they will be minimized to the lowest possible limits and drainable;
- b. All pipes are completely drained, with appropriate slopes;
- c. All surfaces in contact with the process are free of cracks, distortions, scratches, sharp edges, holes, including welds, and must be thoroughly polished;
- d. Demountable assemblies should be made in accordance with DIN11850/DIN11864-1/2/3 for food industry fittings, with appropriate gaskets. Pipes and fittings are to be perfectly matched, with the same diameters to avoid dead zones;
- e. Demountable assemblies inside the process area should have neither bolts nor nuts if possible;
- f. Exterior parts, including covers, to prevent dust accumulation and facilitate cleaning, with appropriate inclinations, shapes;

- g. Lubrication of mechanical parts should be avoided, but should be FDA grade or equivalent if necessary, even if they are not in direct contact with the process;

## 2.2. Construction Materials

Stainless steel grades according to EN 10088-3

All parts in contact with the product:	1.4404 - AISI 316L
Other parts: and nuts:	1.4301 or 1.4307 - AISI 304/304L Bolts 1.4301 or 1.4307 - AISI 304/304L
Support frame/components:	1.4301 or 1.4307 - AISI 304/304L

Gaskets adapted to contact with food, e.g. EPDM, FPM, etc.

Lubricants (oil, grease): supplied FDA 21 CFR certified, approved for use in the food industry (H1 preferred).

## 2.3. Surface Finish

According to EN ISO 4288 - Geometrical specification of products - Rules and protocols for the evaluation of surface finish

Vessel interior: welds ground smooth + mechanical polishing  $Ra \leq 0.8 \mu\text{m}$

Vessel exterior: smooth ground welds + mechanical polishing  $Ra \leq 1.6 \mu\text{m}$

## 2.4. Safety Considerations

The following directives listed below should be considered as a minimum level of compliance with safety regulations and do not exclude any supplier obligations with respect to the standards and technical specifications applicable to the proposed equipment.

The main directives and standards comply with:

- Machinery Directive 2006/42/CE
- EN 294 : Safety of machinery; safe distances to prevent the upper limbs from entering the str
- EN 349 : Safety of machinery. Minimal gaps to avoid crushing human body parts
- Noise emission: maximum noise emission of 80 dB(A), measured at a distance of 1 m from the surface of the device and 1.6 m above the floor. The supplier should also refer to EN ISO 11690-1 and EN ISO 11690-2 to reduce noise emissions.

### 3. Detailed description of the subject matter of the contract No. 1 – MEMBRANE FILTRATION DEVICE

The device consists of the three previously mentioned main modules (sub-components) along with the tanks necessary to ensure continuous operation. All components that make up the device should work together and work in continuous "feed and bleed" mode. Due to the time necessary to restore the efficiency of the membranes (washing), the Ordering Party assumes that on average the Device will work (produce) min. 18h. The remaining 6h. is the time necessary for washing and other work related to good manufacturing practice.

The raw material subjected to the membrane filtration process is an aqueous extract of berries (chokeberry or elderberry or bilberry or similar). The extract is separated from the raw material (particulate matter) by means of a decanter centrifuge (4000 xg) and then filtered by a 50 µm slotted filter or a 20 µm candle filter. The typical dry matter content in the feed is 2-3%.

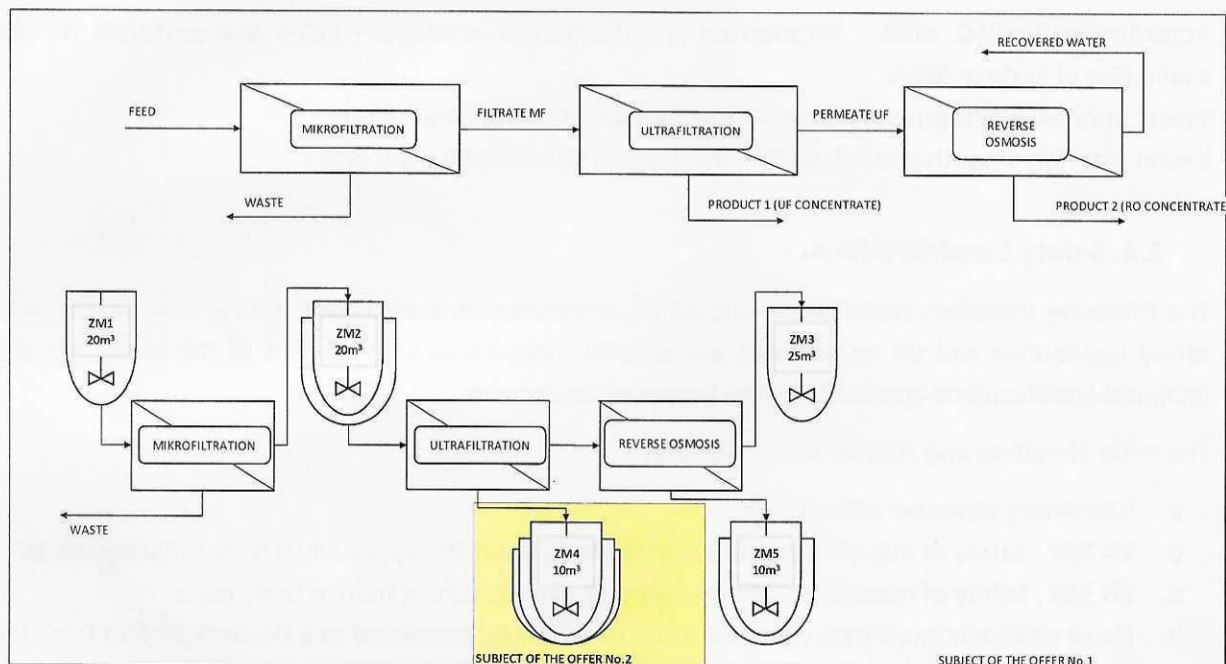


Figure 2. Diagram of Membrane Filtration Equipment

#### 3.1. Mikrofiltration (MF)

The main task of this element of the device is to prepare the raw material for work with the ultrafiltration membrane. At this stage, microorganisms naturally living on the fruit, small impurities or remnants of berry peels that were not removed at the previous filtration stages are removed.

Microfiltration works with the following tanks:

- ZM1 – MF feed tank
- ZM2 – MF filtrate tank / UF feed tank

Microfiltration takes a pre-filtered aqueous extract (50  $\mu\text{m}$  slotted filter or 20  $\mu\text{m}$  candle filter) and feeds it into a circulation loop. The material circulating in the loop is concentrated, while the filtrate ("cut-off" 0.5  $\mu\text{m}$ ) is transported to the ZM2 tank (MF filtrate tank).

MF membranes are located in two housings working in series. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Ceramic membranes with 0.5  $\mu\text{m}$  cut-off, single channel hydraulic diameter  $\geq 4\text{mm}$ , membrane permeability for pure water  $\geq 4000 [\text{l/h}\cdot\text{m}^2\cdot\text{bar}]$  at 20°C;
- b) Filtration surface for MF  $\geq 30.0\text{m}^2$ ;
- c) Average Filtration Efficiency During Work Cycle min. 4000 l/h;
- d) Feed pump and circulation loop pump controlled from frequency converter;
- e) Characteristics of the circulation loop pump allowing operation at a linear speed of min. 5 m/s.
- f) A circulation loop equipped with a measuring orifice or other control measurement equipment to measure the flow in the loop or the linear velocity of the circulating concentrate;
- g) Pressure sensor and flowmeter on the line supplying fresh feed to the loop;
- h) Loop pressure sensors to calculate the pressure drop for each module (PID controller for the circulation loop pump can be set based on the pressure drop);
- i) MF loop temperature measurement;
- j) Control valve on the MF loop for "feed and bleed" operation. A thread draining a part of the concentrate stream equipped with a flow meter (PID controller controlling the degree of opening of the control valve as a function of the flow stream). The stream can be returned to the ZM1 feed tank or be sent to another tank of the Ordering Party;
- k) Each of the MF modules is equipped with a pressure sensor, a control valve, a flow meter. It is possible to control the degree of opening of the MF filtrate control valve based on the PID controller as a function of the transmembrane pressure;
- l) MF circulation loop equipped with heat exchanger, preventing the temperature rise in the loop;
- m) Fully automated control of the device, both the work and washing process;

### 3.2. Ultrafiltration (UF)

The key module of the Membrane Filtration Equipment. The stream of feed material is separated into two fractions differing in the size of particles suspended in water. The concentrate fraction is rich in polyphenols and other organic compounds. The permeate fraction contains sugars and salts naturally occurring in fruits. During the Membrane Filtration process, an aqueous solution of sugars (mainly fructose and glucose) is continuously removed, thus concentrating larger organic molecules in the circulating retentate. The main group of polyphenols are anthocyanins – red-violet compounds with high biological activity. Due to the easy determination of the concentration of anthocyanins in the sample (they are color compounds), they are the main quality parameter of the products.

Ultrafiltration works with the following tanks:

- ZM2 – MF filtrate tank / UF feed tank
- ZM4 – UF concentrate tank (Product 1)
- UF permeate is fed on reverse osmosis (size and necessity of installing the buffer tank in the responsibility of Supplier)

UF membranes operate in three loops of 3 membrane modules in parallel each. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Polymer spiral membranes, PES preferred;
- b) Operation at pH 2-10 and 15-20°C;
- c) Working surface min. 600m<sup>2</sup>, membrane cut-off point at the level of 500Da – 2000 Da, so that the loss of anthocyanins to permeate is less than 10%. The estimated amount of dissolved solids circulating in the loop is 10-12%.
- d) Feed pump and circulation loop pumps controlled from frequency converter;
- e) Characteristics of circulation loop pumps enabling operation with a capacity of min. 75m<sup>3</sup>/h;
- f) Pressure sensor and flow meter on the line supplying fresh feed to the loop;
- g) Pressure sensors to calculate the pressure drop for each loop;
- h) Temperature measurement in UF loops;
- i) Control valves behind the third UF loop output for "feed and bleed" operation. The pipeline "bleeding" the product no 1. equipped with a flow meter (PID controller controlling the degree of opening of the control valve as a function of the flow stream). The stream can be returned to the ZM2 feed tank or be sent to another tank of the Ordering Party;
- j) UF circulation loops equipped with heat exchangers, enabling the production process to be carried out at a temperature of 15-20°C;
- k) Fully automated control of the device, both the work and washing process;
- l) Possibility of direct diafiltration of the third UF loop;

### 3.3. Reverse Osmosis (RO)

During the Ultrafiltration process, the aqueous solution of sugars is continuously removed. This stream is the feed for the next element of the Membrane Filtration Device. The estimated sugar content in this stream will be 1-3°Brix. At this stage, the aqueous solution of sugars is concentrated to the level of min. 15°Brix. The size of the unit should be chosen to be able to process the UF permeate stream. The general requirements for this component of the Membrane Filtration Equipment are listed below:

Reverse osmosis (RO) works with tanks:

- UF buffering tank – permeate stream (if necessary, the Supplier is responsible for scaling the buffer)
- ZM5 – RO concentrate tank (Product 2)

- ZM3 – RO permeate tank (recovered process water)

RO membranes work in two loops. The first loop consisting of two modules is responsible for the initial dewatering of the aqueous solution of sugars. The second loop, consisting of at least one module, is responsible for obtaining the final degree of concentration.

- a) Polymer spiral membranes;
- b) Working surface min. 500m<sup>2</sup>;
- c) Feed pump and circulation loop pumps controlled from frequency converter;
- d) Pressure sensor and flow meter on the line supplying fresh feed to the loop;
- e) Pressure sensors to calculate the pressure drop for each loop;
- f) Temperature measurement in RO loops;
- g) Control valves behind the third UF loop output for "feed and bleed" operation. The pipeline "bleeding" the product no 1. equipped with a flowmeter (PID controller - the degree of opening of the control valve as a function of the flow stream). The stream can be returned to the ZM2 feed tank or be sent to another tank of the Ordering Party;
- h) Fully automated control of the device, both the work and washing process;

### 3.4. ZM1 tank

Feed tank for the Microfiltration module. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Single-walled tank made of 1.4404 steel with a working capacity of 20m<sup>3</sup>;
- b) Inner diameter of the tank max. 2200mm;
- c) The tank is placed on 4 adjustable legs, equipped with a ladder with a railing on the tank;
- d) Frame agitator, min. 20 rpm;
- e) Min. Two CIP washing nozzles;
- f) Level measurement, minimum and maximum level sensors, temperature measurement;
- g) Filling and drain pipes equipped with automatic valves;
- h) Side manhole with opening sensor;

### 3.5. ZM2 tank

Feed tank for MF Ultrafiltration/filtrate module. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Double-walled insulated tank with a working capacity of 20m<sup>3</sup>, inner wall made of 1.4404 steel, outer jacket made of 1.4301 or 1.4307 steel;
- b) Inner diameter of the tank max. 2200mm;
- c) Insulation layer min. 100mm on both the cylindrical part and the bottom;

- d) The tank is placed on 4 adjustable legs, equipped with a ladder with a railing on the tank;
- e) Frame agitator, min. 20 rpm;
- f) Min. Two CIP washing nozzles;
- g) Level measurement, minimum and maximum level sensors, temperature and pH measurement;
- h) Filling and drain pipes equipped with automatic valves;
- i) Side manhole with opening sensor;

### 3.6. ZM3 Tank

Permeate tank for Reverse Osmosis (RO) module. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Single-walled tank made of 1.4404 steel with a working capacity of 25m<sup>3</sup>;
- b) Inner diameter of the tank max. 2200mm;
- c) The tank is placed on 4 adjustable legs, equipped with a ladder with a railing on the tank;
- ~~d) Frame agitator, min. 20 rpm;~~
- e) Min. Two CIP washing nozzles;
- f) Level measurement, maximum level sensors, temperature measurement;
- g) Filling and drain pipes equipped with automatic valves;
- h) Side manhole with opening sensor;

### 3.7. ZM5 Tank

Concentrate tank for Reverse Osmosis (RO) module. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Single-walled tank made of 1.4404 steel with a working capacity of 10 m<sup>3</sup>;
- b) Inner diameter of the tank max. 2200mm;
- c) The tank is placed on 4 adjustable legs, equipped with a ladder with a railing on the tank;
- d) Frame agitator, min. 20 rpm;
- e) Min. Two CIP washing nozzles;
- f) Level measurement, minimum and maximum level sensors, temperature measurement;
- g) Filling and drain pipes equipped with automatic valves;
- h) Side manhole with opening sensor;



#### **4. Detailed description of the subject of the contract No. 2 – INSULATED TANK min. 10 m<sup>3</sup> (ZM4)**

Concentrate tank for Ultrafiltration (UF) module. The general requirements for this component of the Membrane Filtration Equipment are listed below:

- a) Three-walled, insulated, glycol-cooled tank with a working capacity of min. 10 m<sup>3</sup>, inner wall made of 1.4404 steel, outer walls made of 1.4301 or 1.4307 steel;
- b) Inner diameter of the tank min. 1600mm;
- c) Inner wall thickness min. 4mm;
- d) Cooling jacket on both the cylindrical part and the bottom;
- e) Insulation layer min. 50mm on both the cylindrical part and the bottom piece;
- f) The tank is placed on 4 adjustable legs, equipped with a ladder with a railing on the tank;
- g) Manhole min. DN500;
- h) Air release vent valve;
- i) Frame agitator, min. 35 rpm;
- j) Min. Two CIP washing nozzles;
- k) Level measurement, minimum and maximum level sensors, temperature measurement;
- l) Filling and drain pipes equipped with automatic valves;
- m) Sampling valve;

#### **5. Final documentation**

To be released with hardware.

User manual for production and maintenance in English or Polish, except for certificates issued for purchased items and materials, in their original language.

In two printouts and one complete electronic version with:

- a. Drawings “as built”;
- b. Process and instrumentation diagram “as built”;
- c. Electrical and pneumatic diagrams (if any);
- d. Declaration of Conformity;
- e. Complete technical documentation for accessories (mechanical seal, electric motor, valves, etc.), with a clear indication of the model/series of material installed on the unit;
- f. User Instructions for Use and Maintenance.
- g. Material Certificates

#### **6. Packing, transportation**

Cost of packaging and transport on the side of the Supplier - DDP Łomża (Poland).

#### **7. Installation, commissioning and training**

Unloading and introduction of the device to the production area, mechanical assembly in responsibility of the Ordering Party. The Ordering Party shall ensure that the necessary utilities are supplied to the



room in which the Subject of the Order will be installed. Electrical assembly, supervision of mechanical assembly and delivery of all components necessary for the assembly of Order Items is the responsibility of the Supplier.

## 8. Warranty

Not less than 12 months

**At the stage of selecting a supplier, the Ordering Party reserves the right to conduct a reference visit in order to verify a technology similar to the one offered operating in industrial conditions.**

*Kamil Pietruszyński*