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Department of Environmental Technology
Sustainability Science and Solutions
Master's thesis 2019

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CIRCULAR ECONOMY AND ITS IMPLEMENTATION AT EVAPORATION UNIT PROCESS (CASE LESAFFRE LLC)

Examiners: Assistant Professor Ville Uusitalo
Assistant Professor Jarkko Levänen

ABSTRACT

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Circular economy and its implementation at production process (case LESAFFRE LLC)
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Circular economy and sustainable development need to become implemented into societies and businesses. This thesis considers the concept of circular economy business model and shows possibilities and instruments for its application and promotion. This thesis also provides experience of circular economy implementation in case of Lesaffre LLC and answers the question: how sustainable development goals can be achieved through transition to circular economy? The company faced with wastewater problem, which did not comply with Russian legislation, at yeast manufacturing plant. Exceeding of maximum permissible concentrations led to huge fines. Therefore, it was decided to implement evaporation unit technology, which allowed to treat water for reusing at the plant and to produce new products for agriculture and livestock. Environmental, social and economic sustainability of the project as well as quality characteristics of wastewater after treatment are analyzed.

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In Lappeenranta 25 November 2019

Elizaveta Berezkina

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LIST OF SYMBOLS

Subscripts

mg/l milligram per litter

Abbreviations

BOD Biochemical oxygen demand

BPE Boiling point elevation

CIP Cleaning in place

COD Chemical oxygen demand

DT Difference of temperature between steam and vinasses

GHG Greenhouse gas

LLC Limited liability company

MPD Maximum permissible discharges

1 INTRODUCTION

Our world faces the problem of natural resources depletion and large-scale environmental problems. A way to decrease consequences is development of sustainable development. Sustainable development can be defined as development that "meets the needs of the present, without undermining the ability of future generations to satisfy their own needs", which unites three areas: economic, social and environmental (International Institute for Sustainable Development, 2019).

The current economic system is based on the linear economy “take, make, dispose”. It led to the fact that today humanity consumes 1.7 times more than the planet can produce (Kingdom of Netherlands, 2018). What is also important, the linear model does not take into consideration environmental and social aspects, which are two of the three pillars of sustainability, and regarding it, the current economy is not sustainable. The circular economy is based on the principle of 3R- Reduce, Reuse, and Recycle. Circular economy is a model where used materials are processed or released into the biosphere without a negative effect. One of key feature of the circular economy is following: waste is not a garbage, it is a valuable resource.

Nowadays companies operate in a highly competitive environment. New technologies, the continuous development of society have an impact on changing business conditions. As a result, industrial companies are constantly forced to improve their internal and external processes. In addition, companies are trying to minimize the operational costs and keep quality of products. To maintain a stable strong position in the market, it is necessary to form and strengthen competitive advantages; and environmental and social aspects play significant role in company success. Therefore, attention to sustainable development is constantly growing.

Today, the United Nations is actively developing and promoting sustainable development. The United Nations developed “2030 Agenda for Sustainable Development”, which consists of 17 goals in different fields (Figure 1). These goals unite all countries - developed and developing - and the main objective of them is to contribute for prosperity and protect the

plant at the same time. The goals balance all three components of sustainable development: economic, social and environmental.

Figure 1. 2030 Agenda for Sustainable Development (Sustainable Development Goals, 2019)

Decision for goal №12 is a transition to circular economy that means manufacturing process and consumption with maximum efficiency in use of resources, zero waste generation and minimization of negative effects on the environment. Moreover, transition to circular economy partly allows to reach following goals:

- Clean water and sanitation;
- Affordable and clean energy;
- Sustainable cities and communities;
- Responsible consumption and production;
- Climate action.

The development of a circular economy is a condition for achieving sustainable development. In 2015, European Commission developed Circular Economy Action Plan. The main aim is development of carbon neutral, resource-efficient and competitive economy. Circular Economy Action Plan consists of 54 actions. These actions contributed achievement of “2030 Agenda for Sustainable Development”.

There are two main ways to promote principles of circular economy: through multi-national companies and governments. This paper considers experience of implementation circular

economy in company Lesaffre (Russia) on example of evaporation unit, which allows to treat wastewater and turn production waste into new products.

The aims of the study are following:

- Describe concept of circular economy;
- Consider implementation of circular economy and evaporation unit technology on example of Lesaffre LLC;
- Consider environmental, social and economic sustainability before and after implementation of evaporation unit with a comparison of results.

For the paper, literature review and practical experience at production site were applied for data collection.

2 CONCEPT OF CIRCULAR ECONOMY

The chapter considers circular economy formation and concept, difference between linear model and closing cycle, business models and barriers for transition to circular economy.

2.1 From linear model to circular economy

Traditional economy can be shown as a linear approach, which consists of "take, make, dispose". This approach is one of the reasons of sustainability problems, because linear economy means usage of resources in unsustainable way, waste generation, natural resources depletion and so on. In circular economy, the economic cycle has the same steps as in the linear model, but the cycle is not interrupted here. The principal difference is following: after goods are consumed, waste is not disposed at landfills, but sent to waste recycling centers, where it is sorted and processed for the further production of new goods. The difference between linear and circular models is presented in Figure 2.

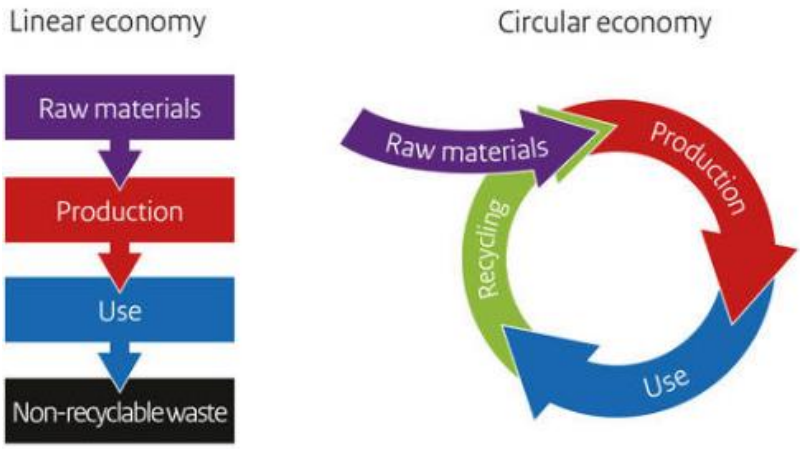


Figure 2. Types of economies (Government of Netherlands, 2019)

The first concept of closing cycles appeared in 1960s-1970s and it is directly related to the transition from industrial to post-industrial (informational, digital) society and economy. However, the term "circular economy" was presented by environmental economists D. W. Pearce and R. K. Turner in the book Economics of Natural Resources and the Environment in 1990. The main idea of the book is to consider the Earth as a closed economic system: a

system where economy and environment are characterized not by linear relationships, but by circular relationships. To achieve a win-win situation for economy and environment, authors proposed a closed cycle of materials in the economy (Rizos et al. 2017, 2-5.).

Further, the idea of closed cycle has been developing and adopted for business. Nowadays there are different schools of thoughts like as cradle-to-cradle, biomimicry, blue economy etc, which are covered economic, social and environmental aspects. The main characteristics of circular economy are:

- Design out waste and pollution;
- Keep products and materials in use;
- Regenerate natural systems (Ellen Macarthur Foundation 2019.).

Now circular economy can be defined as “where the value of products, materials and resources is maintained in the economy as long as possible, and the generation of waste minimised”. (Eurostat 2019).

2.1.1 Circular economy model

Nowadays there are more than ten different visualizations of the circular economy model, but all of them have a similar structure. However, the model of the circular economy based on the development of the Ellen MacArthur Foundation is the most widespread and comprehensive model for today (figure 3).

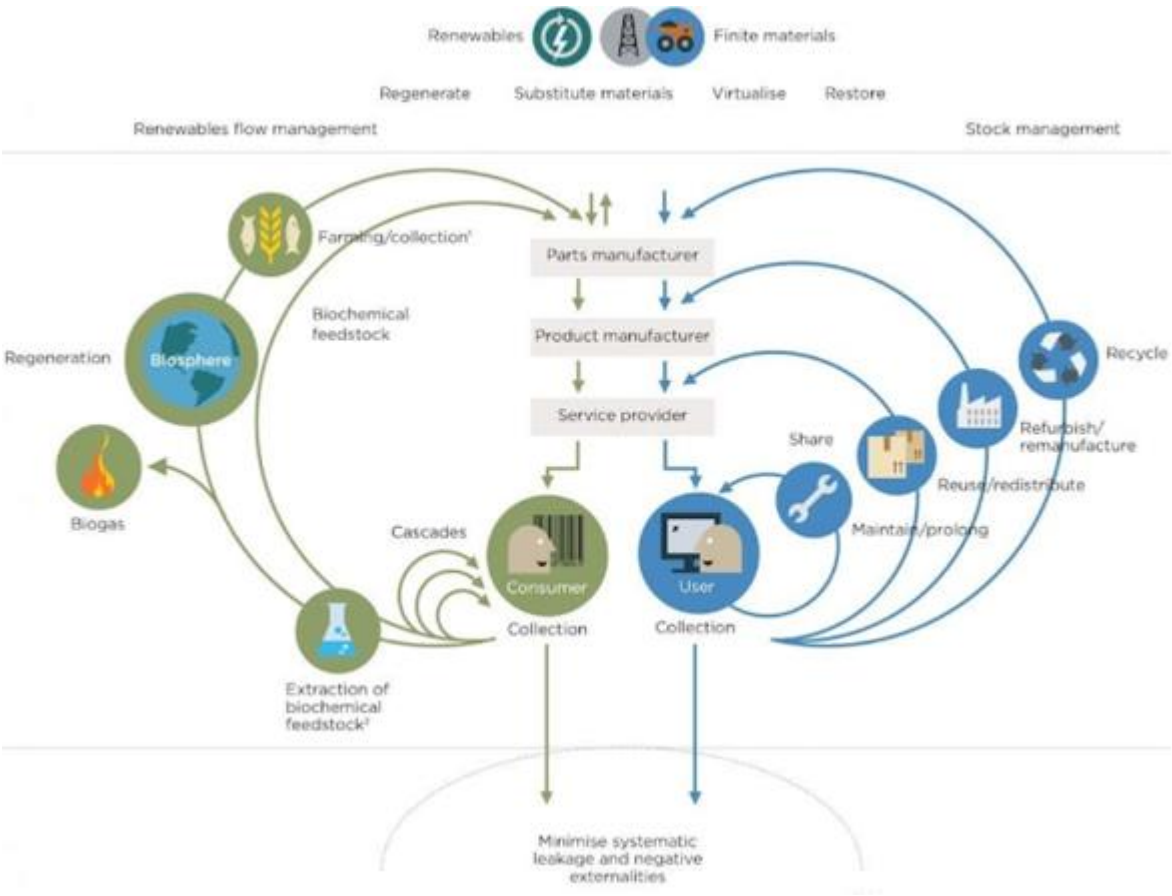


Figure 3. Circular economy model (Ellen Macarthur Foundation 2019).

According to this model, the circular economy aims to ensure resource efficiency and the absence of waste. The model consists of two cycles – biological and technological. It is very important to separate these cycles because they include different material cycles. Within the **biological cycle**, this scheme implies the following chain: after use, the waste (non-toxic) returns to the natural environment and becomes a breeding ground for bacteria for implication in further biological processes. Then "waste" again turns into the form of products of farm and agricultural activities. The **technical cycle**, which is formed by closed supply chains, is based on the following:

- *Maintain/prolong* - to extend the product life cycle by maintaining its performance;
- *Reuse/redistribute* in original or modified form;
- *Refurbish/remanufacture* product or its parts;
- *Recycle* waste and product. There are three possibilities: upcycling (processing into new materials of better quality), recycling (recovery of

materials for the original purpose) and downcycling (conversion to materials of lower quality). (Ellen Macarthur Foundation 2015.)

2.1.2 Basic principles of circular economy and its benefits

The circular economy is based on three important principles:

1) Preservation and increase of natural capital by managing limited stocks and balancing the flow of renewable resources;
2) Optimization of resources yields by the circulation of products, materials, and components with the highest utility at all stages in both biological and technical cycles all the time;
3) Contributing to the development of systems efficiency by identifying negative external factors and subsequent redesign of production activities. (Ellen Macarthur Foundation 2015.)

Table 1 presents results of investigation: there are six action that can help to government and business for circular economy transition. These actions are called ReSOLVE and consists of Regenerate, Share, Optimise, Loop, Virtualise, Exchange. All of these action are correlated and able to accelerate each other.

Table 1. ReSOLVE framework (Ellen Macarthur Foundation 2015)

Regenerate	- Transition to renewable materials and energy; - Conservation and restoration of ecosystem health; - Returning restored biological resources to biosphere;
Share	- Usage of shared assets (for instance, cars, buildings and rooms and etc); - Secondhand or reuse; - Extension of service life due to constant maintenance, durable design, modernization and etc;
Optimize	- Efficiency increase of product; - Waste removing in supply chain and production; - Usage of big data, optimization and automotization, remote sense;
Loop	- Remanufacturing of product and its components;

	- Materials recycling; - Anaerobic digestion; - Extraction of biochemical substances from organic wasteж
Virtualize	- Direct dematerialization (for instance, travelling, CDs and DVDs and etc); - Indirect dematerialization (for instance, online shopping);
Exchange	- Replacement of old materials with advanced non-renewable materials; - Implementation of new technologies; - New product selection (for instance, multimodal transport).

Circular economy aims to decrease negative effect on environment and make better resource performance. This type of economy can be very valuable for humanity in following:

1) **Decreasing of greenhouse gas (GHG) emission.** As it was mentioned above, circular economy means efficient use of resources in sustainable way. Thus, it leads to less waste generated, less natural resources, fossil fuel extraction, and prolonged life for products. These actions together and their positive effect have significant influence for reducing GHG (E-CSR 2019.).
2) **Healthy soil.** One of the characteristics of circular economy is regenerate natural system. Soil degradation cost is estimated about US$ 40 billion annually worldwide. These costs include loss of biodiversity, increasing is fertilizer usage. In the framework ReSOLVE, anaerobic digestion can help maintain balance (E-CSR 2019.).
3) **Reducing negative externalities.** This point unites prevention of soil degradation, water contamination, air pollution, climate change as processes are well managed (Wilts 2017).
4) **More saved resources.** Circular economy needs lower amount of raw material in comparison with linear economy in long-term outlook. It is allowed to save up to 70% of materials. Another positive aspect is related to reducing landfills and as a consequence is reducing pollution (Wilts 2017.).
5) **Unemployment reduction.** According to the study provided by McKinsey and the Ellen MacArthur Foundation (Ellen Macarthur Foundation 2015), transition to

circular economy has a potential for employment growth. Circular economy aims to make products more durable, therefore there is a potential for new job places, like mechanical engineers and designers, and new businesses – remanufacturing of components and parts, product refurbishment offering specialized experience and knowledge. The estimated growth in adding new jobs is around 0.2-3% (Ellen Macarthur Foundation 2015.).

6) **Volatility decreasing and stable supply chain.** Amount of used raw materials for manufacturing will be reduced in circular economy model. Instead of it, production sites are going to use recycled and transformed materials. It means, that companies will be less dependent on price volatility on raw materials as well as on geopolitical crisis in terms of supply chain (E-CSR 2019.).

2.1.3 Barriers for transition to circular economy

Despite the benefits, circular economy implementation goes slowly due to barriers. The reasons are following:

1) Some business areas, regions and industrial sectors can receive more benefits from transition to circular economy model than others can. Moreover, some of them can lose their business, e.g. producers of new raw materials.
2) Current legislation also breaks the transition from linear economy model to the circular one. According to the legislation, some types of used materials have limitations for further usage because they are classified as waste and needs new technologies for processing. It is worth noticing, that environmental permits are compulsory for waste processing and its receiving is quite complicated. Another important point, that legislation changes are needed in many countries approximately at the same time (Bourguignon 2016.).
3) Nowadays guideline, road map or standard, which can help with transition, are mostly inadequate and do not provide detailed information. There is only general recommendations and instruments, like ReSOLVE framework. It is related to the specific of business, particular market sector and product. Moreover, there is no clear criteria, which can estimate and analyse implementation of circular economy in business (Circular Academy 2019.).

4) Another challenge is related to investors' thinking, which are used to apply "take, make, dispose" approach. Therefore it is more difficult for people to develop and implement circular economy business models (E-CSR 2019.).
5) To replace linear economy by circular economy, the second one should be viable from the economical point of view and cost-effective. However, the question with cost-effectiveness arises: sometimes usage of virgin natural raw materials is much cheaper than usage of recycled materials. Price for recycled materials includes many factors as designing of new technologies, cost of construction, receiving licence and permit for its operation to pay back investments (E-CSR 2019.).

Concluding, one of the main tasks for the world is separation of economic growth and consumption of natural resources. The problem is caused by linear economy model and excessive consumption of natural resources, which led to the aggravation of environmental problems and natural resource crisis, which, according to some estimates, will come by 2050. One of the solutions is to achieve sustainable development: actions are integrated in three areas: economic, social and environmental. An important condition for achieving sustainable development is the transition to a circular economy. Iimplementation of circular economy needs a complex approach at different levels – government, different businesses, investors.

2.2 Circular economy business models

According to research "Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth" provided by Accenture, five circular economy business models were defined. Accenture analysed more than 120 companies, which carried out activities to increase the efficiency and productivity of resources through innovation. Figure 4 presents five circular economy business models:

1) Circular suppliers;
2) Resource recovery;
3) Product life extension;
4) Sharing platforms;
5) Product as a service.

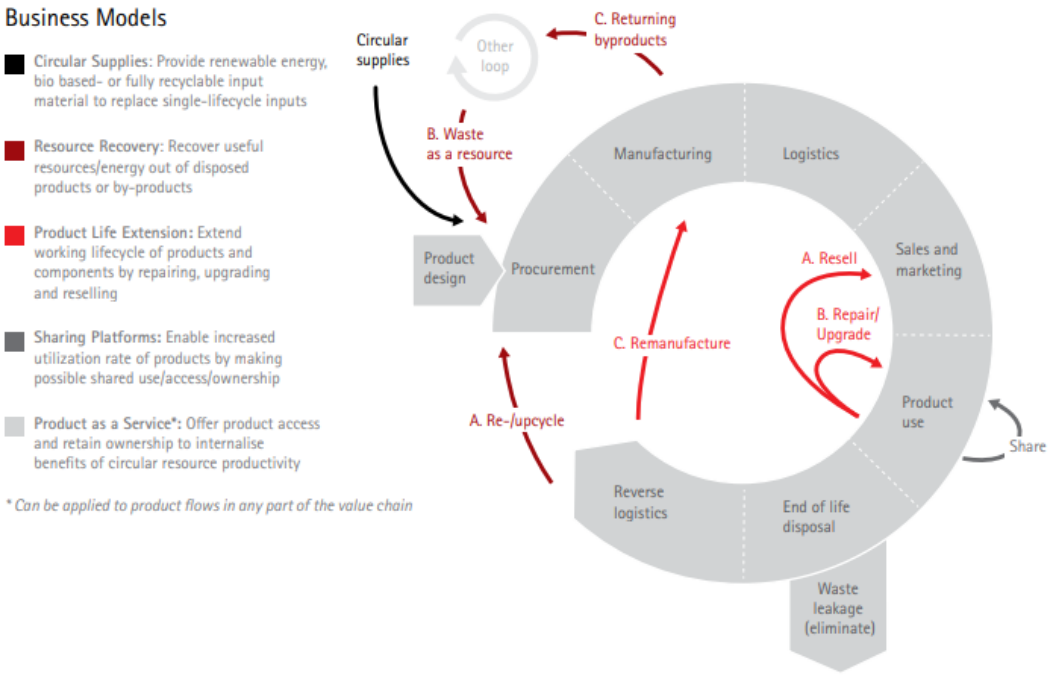


Figure 4. Five circular economy business models (Accenture Strategy 2015)

This classification is based on the circular economy model: product design -> supply of resources -> production -> logistics -> sales and marketing -> product use -> end of use -> reverse logistics, which returns products and materials on a new circle. Circular business models consist of optimization of manufacturing processes, life-extension of product, material recycling and replacing product ownership with services and leasing.

2.2.1 Circular suppliers

The circular suppliers model is based on the supply of recyclable, fully renewable, biodegradable resources that underlies production and consumption systems. Through them, companies replace linear approaches to resources and gradually stop using limited resources while reducing waste and eliminating inefficiencies. This model is the strongest for businesses engaged in scarce goods or those that have a significant environmental footprint.

For example, Dutch company Royal DSM, which is engaged in the field of health and nutrition, is one of the players at the initial stage of adopting this business model. It developed cellulosic bioethanol technology, which is a by-product from crops. Cellulosic bioethanol is a fuel that is more environmentally friendly than fossil fuels and it allows to

reducing amount of waste, decrease air pollution, and also create more than 70,000 jobs (Accenture Strategy 2015.).

2.2.2 Resource recovery

Recovery of value at the end of product's lifecycle to supply into another promotes return chains and transforms waste into value through upcycling. Based on traditional recycling markets, this business model uses new technologies and capabilities to recover almost any resources/product to any level of equivalent value to or even above the initial investment level. This business model have many solutions from industrial symbiosis to integrated closed loops and Cradle-to-Cradle design where products can be recycled to new ones.

For instance, carpet producer, Desso, developed a technology Refinity, which allow to separate yarn and other different types of fibres. After purification, yarn is returned to the manufacturing process for the secondary use (Accenture Strategy 2015.).

2.2.3 Product life extension

Application of product life extension model allows business to prolong products' lifecycle and assets. To maintain or even improve products through repair, modernization, remanufacturing or product remarketing, company uses value that might be lost due to discarded materials. Due to life extension, company can receive additional revenue. Using this model, a company can guarantee that products remain useful from economical point of view as long as possible and also that product upgrades are carried out in a more focused manner (for example, replacing only an outdated component, and not the entire product). This model is suitable for most B2B segments (for instance, industrial equipment) and B2C companies that serve markets where the products being sold (or re-selling) are common or whose new products usually consist only of partial additional advantages for customers compared to with the previous version.

For example, for promotion of product life extension Google designed a "Project Ara". Innovative and ambitious project was warmly received by community. The main idea is ability to customise smartphone in accordance with user needs. It helps easily change basic

modules to more professional and make phone more individual and more functional. Also user can repair or change broken part, like screen or battery to prevent buying new one. It helps to prolong lifetime of product by reduce using virgin resources for manufacturing new phones and, as consequence, minimising the volume of E-waste generating (Accenture Strategy 2015.).

2.2.4 Sharing platforms

The Sharing Platform business model promotes an idea that all product users and companies can collaborate in product sharing. It leads to rational using and preventing over using of power and underutilization, increasing productivity and making user value creation. This model could benefit the companies whose have low level of utilization or ownership. However, this model are commonly used by companies with high level of utilization without any manufacturing powers. It makes a pressure on traditional manufactures.

As an example, ride-sharing company Lyft, Inc created new way of travel market by promotion sharing platform business model. Lyft's co-founders understood that cars, which are used in cities, are underutilized and 80% of free space were empty. The company helps to fit the seats via mobile app where the persons, who needs a seat, can find a person who this seat have and want to share a car. Pickup and ride fee in this case is approximately lower by 20-30% in comparison with taxi fee. Fee passes through the app and Lyft have 20% from them. This case brought also a good reputation for Lyft because the company have large investment. In April 2014 Lyft declared a new round of funding worth 250 million dollars with a total 333 million dollars thus far. This amount of cash helps Lyft to prolong their business global expansion (Accenture Strategy 2015.).

2.2.5 Product as a service

The Product as a Service business model promotes an idea when a user in accordance with lease or pay-for-use arrangement shares a product with other users. Based on this model, companies focus not on manufacturing volume, but on performance. It means that products start to be reusable and longevous. In sharing the cannibalization risks and costs are reduced.

This model is effective for those, who have high products' cost of operation share and have skill advantage in maintenance than customers.

For instance, Michelin – one of the leaders in tires manufacturing in according to Product as a Service business model provides "tires as a service" to customers through lease arrangement purchase tires outright. Customers pay a fee from miles driven on these tires, without one-time purchasing for ownership and it makes cost lower. Another advantage for customers is absence of a deal with maintenance or hassles of punctures. Because of this business model Michelin focuses on manufacturing longer lasting tires. And after receiving wearied out tires back, Michelin is interested in making sure through design, technology and material selection that they can reprocessed these tires into new one or for making new product (Accenture Strategy 2015.).

2.3 Legislation

Companies' involvement is important for the transition process from linear to circular economy, but governments' role is critical and significant for the process. Using power, governments can create needed conditions, promote correct ideas at local, national and global levels as well as be role model, e.g. in implementation of supply chain through public procurement. (Accenture 2014, 20.)

Governments should achieve progress in creating policies, which can simplify and help transition and nurtures circular economy business models. Essential policies in this question could be shifting taxation from labor to resources, setting specific recycling targets for industries, making companies responsible for products throughout their life cycles, implementation of tax premiums for the use of regenerated resources. (Accenture 2014, 20.)

European Commission created a Circular Economy package in 2014 and updated it in 2015, which consists of:

- Report on the implementation of the Circular Economy Action Plan - press release - questions and answers;

- Staff working document with details on the 54 actions included in the action plan;
- Staff working document on Sustainable Products in a Circular Economy;
- Staff working document on the assessment of the voluntary pledges under Annex III of the Strategy on Plastics;
- Guidance and promotion of best practices in the mining waste management plans;
- Summary Report of the Public Consultation on the interface between chemicals, product and waste legislation;
- Report on improving access to finance for circular economy projects;
- Report on Horizon 2020 R&I projects supporting the transition to a Circular Economy;
- A circular economy for plastics – Insights from research and innovation to inform policy and funding decisions;
- Eurostat press release: Circular Economy in the EU (European Commission 2019.).

In practice, significant attention is given to waste in terms of "2030 Agenda for Sustainable Development" and circular economy. EU is constantly changing and improving environmental legislation. Waste Framework Directive (2008/98/EC) gives definitions to waste and product, changing status from waste to secondary raw materials and end-of-waste criteria. It helps for consideration of materials' utilization. There is also landfill ban for organic waste. In the framework of the Directive 2008/98/EC, EU countries increased costs for landfilling demolition and construction waste with aim to speed up recycling rate of construction materials like as timber, concrete and so on. (European Commission 2019.).

Under Waste Framework Directive, waste hierarchy was developed (Figure 5), where waste prevention is the most preferable alternative and waste disposal is the worst one. Prevention means implementation of practices like usage of less material in manufacturing and design, lifetime extension. Waste hierarchy is obligatory to comply from legal point of view: anyone is responsible for consideration of better alternative before choosing disposal.

Figure 5. Waste hierarchy (2008/98/EC)

In Russia the situation is slightly different. Statistics show that the most polluting sector in Russia is mining - the extraction of fuel and energy minerals. They accounted for 3106.6 million tons of waste from the total mass in 2015, what equals more than half of all waste. The recycling rate in Russia is only 5–7%, and more than 90% of the garbage goes to landfills, therefore the amount of disposed waste is growing every year. Russia faces serious barriers for the transition to a circular economy. Firstly, there are classical reasons for the slowdown of the country's innovative development, such as the current raw material structure of the Russian economy, a high level of corruption, difficulties in financing modernization and attracting foreign investment, and other related problems. Secondly, additional economic and cultural barriers can be distinguished: government support for the extractive sector (coal, gas, and oil), the Russian “distrust” mentality, low level of awareness and understanding of the consequences of linear economy and lack of respect for nature. (International Centre for Trade and Sustainable Development 2017.).

However, Russian government announced the transition to a new environmental policy “Ecology” for minimization of waste disposal with a focus on recycling. It consists of four large blocks: “Air”, “Water”, “Waste” and “Biodiversity”. Russian government made significant changes in Federal Law - 89, like implementation of environmental tax for non-recycled packaging, ban on disposal of some waste (e.g. e-waste). The next step is separate waste collection, especially municipal solid waste. Its organization is a complex task, which includes economic, legal and social components; separate collection is possible only with

close cooperation of the state, business and society. According to the Ministry of Industry and Trade, there will be 70 Ecotekhnoparks, and they will utilize 80% of municipal solid waste by 2030 in Russia. Ecotekhnoparks is a complex of facilities combined with energy and interdependent material and raw materials flows and connections, including technological and laboratory equipment used in waste recycling, utilization and disposal activities (Vorotnikov et al. 2018.).

Important moment for legislation is its predictability for corporations. It is related to long-term planning and development of their operational activity. Predictable legislation and its changes allows to prepare to changes in advance and adapt business according to new regulations in more logical way. It also gives time to reduce risks and plan investments and innovations in the right direction (Levänen 2015.).

2.4 Supporting tools for the circular economy realization

Circular economy business models and innovations can appear and rise in environmentally conscious and urbanized environment. One the most significant aspects of it is financing. The main sources of support and financing for circular economy business projects are corporations (large companies), governments, banks and institutional investors (large stakeholders) that provide joint efforts to access financing.

1) **Corporations.** In order to stimulate circular innovation and start-ups, additional risk capital and business support are required. Corporations will greatly benefit from providing a “path to profitability” for companies at an early stage, for example, by offering venture capital. To reduce linear risks and create a sustainable business model, circularity should be part of the corporate strategy.
2) **Government** can open access to venture capital funds by providing additional stimulus for financing providers and also raising market transparency. The circular economy was identified by leading global economies as an important area for growth with high social influence. Important subsidies and grants are allocated for circular initiatives. New institutions should have a mandate to close the start up financing gap as an important part of their broader mission.

3) **Banks** should create experience in circular economy business models and design innovative approaches to mitigate their risks in order to make them "acceptable to banks". As start-ups become small and medium-sized enterprises, they usually begin to gain access to bank lending. As in other innovative markets with large technological components, bank financing of the circular economy is more complex. The cost of assessing creditworthiness under established procedures is disproportionate to significant risk of loans and the relatively small size.
4) **Institutional investors** should make circulation a priority in their investment program: fully circular corporations have not yet appeared, but the corporate trend of diversification from linear enterprises is starting to appear all over the world. Corporations can get the maximum benefit from transition to circularity, but the costs of transients are difficult to determine. As responsible shareholders of corporations with long-term commitments, institutional investors should create expertise and help corporations in their further circular strategy. Circularity should not be considered as separate effort, it can be integrated into an existing investment strategy of sustainable development for the majority of institutional investors, in particular to achieve sustainable development goal 12 (responsible consumption and production) (Wyman 2017.).

The next aspect is related to design, because design development determines all subsequent product life cycles. Cradle to Cradle Innovation Institute supports development of fully circular product design. Cradle to Cradle Innovation Institute is a nonprofit organization that manages the standard Cradle to Cradle Certified product, providing manufacturers and suppliers the criteria and requirements for continually improving product composition and technology (C2C-Centre.).

In addition, there are also international standards that reflect the aspects of circular activity. The principle of the circular economy and the ISO 14001: 2015 standard are based on similar concepts: waste reduction and taking measures to reduce risk in terms of the companies' environmental impact. There are also some principles that can be used to achieve the goals of ISO 14001: 2015 standard and to apply circular economy:

- Zero waste as an indicator of efficiency at enterprises;
- Ecodesign – integration of environmental issues into the product design;

- An open loop system - a system in which products, materials and products' components can be recycled, e.g. into new different products;
- Downcycling of electronics to the state of raw materials to reduce environmental impact (14001 Online Consultation Center.).

2.5 Steering instruments for the circular economy

There are also several steering instruments for circular economy promotion. Steering instruments can be defined as actions, which are used by public authorities to realize political aims and guide citizens and corporations to the right direction. Steering instrument are divided on administrative-legal, informative and economic instruments, self-management, planning and joint control. Regulations, procedures, rules, permits procedures and restrictions are related to administrative-legal instruments. Example of the instrument is Waste Act and environmental permit procedure. Informative instrument consists of environmental communication, training, eco-labels, environmental impact assessment and different kinds of environmental researches. The next one, economic instrument, includes indirect and direct fees and incentives, that can have influence of costs of different actors. For instance, it can be emission trading, environmental fees and taxes, financial supporting of renewable energy and producer responsibility. Following instrument is planning and it refers to public system, which help to control regions and different types of activities like as land use, energy savings, mobility management and etc. Joint control refers to collaboration of public and private sectors with voluntary control. Voluntary environmental agreements such as promotion of energy efficiency or waste recycling, play there the most significant role. The last one, self-management is mostly related to business. Companies aim to apply different voluntary methods like as eco-labels, additional certification, social responsibility, eco-systems and audits.

Several examples of steering instruments were described above. Implementation of circular economy is quite big challenge for world, therefore there is a common situation when steering instruments are used in a combination to promote innovations and adapt new concepts for operation. Figure 6 demonstrates examples of such collaboration and implication of them into technical and biological cycles.

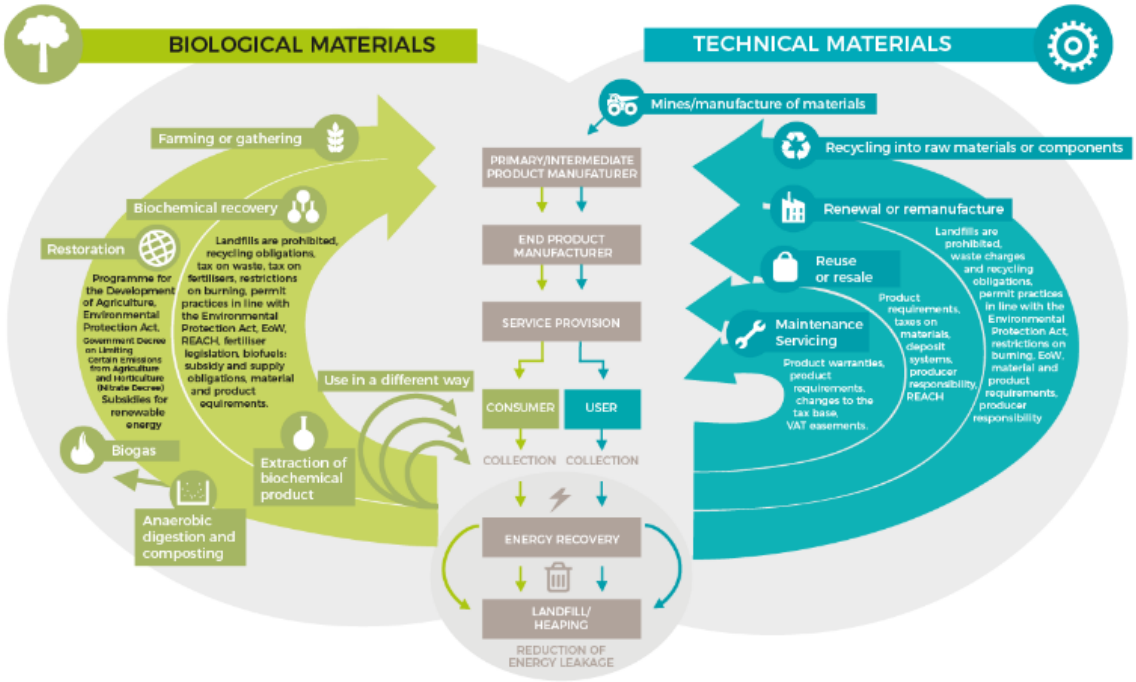


Figure 6. Combination of circular economy steering methods within technical and biological cycles. (Circular.now)

3 LESAFFRE AND ITS EXPIERENCE OF IMPLEMENTATION EVAPORATION UNIT

Technological part describes Lesaffre, its approach and contribution in implementation circular economy with evaporation unit example on it.

3.1 Company profile

Company Lesaffre was made by two landowner Lui Lesaffre and Lui Bonduelle. In 1853 they built a grain alcohol and Holland jinn factory in Marquette-lez-Lille commune in the north of France. After 10 working years, they bought a mill in Marcq-en-Baroeul for future re-equipment to alcohol factory. In base on manufacturing a Societe Industrielle Lesaffre was founded, which became over time a main driving force for commercial and manufacturing prosperity of yeast production. In 1872 Baron Maks de Springer brought from Vena, Austria an idea of getting yeasts from fermentation grain must and selling it to bakers. In addition, he built first yeast factory in Maisons-Alfort, France. In these times bakers used own made ferment and in some situations yeasts from beer factories. In 1873, Lui Lesaffre and Lui Bonduelle began to produce compressed yeasts in Marcq-en-Baroeul, where they bought mill. In 1901 Lesaffre and Bonduelle families decided to work separately. Company was divided to 3 business: Bonduelle, Lesaffre & Cie (alcohol and yeast) and Lesaffre Freres (sugar factory and distillation). In 1923 Government sharply down the prices of grain alcohol and for saving business Lesaffre started to use molasses as new raw material for yeast production. Until now Lesaffre are using molasses as the main raw material for manufacturing.

The mission of Lesaffre group is working together to better nourish and protect the planet.
It means that the company tries jointly to develop and design their products and services with their customers; working in improving the quality of food to preserve the health of living in long term and do business with respect for planet.

Lesaffre Group is presented in Africa, Latina and North America, Asia Pacific, Europe and Middle East. Totally, there are 185 countries where products and services are distributed. All over the world, the company has 66 production sites, 570 R&D experts and 60 partners' universities and research centers. In Russia, Lesaffre, has one plant in Saint-Petersburg, which produces bread ingredients, and three yeast plants in Uzlovaya, Voronezh and Kurgan.

3.1.1 Company's corporate social responsibility

Lesaffre pays a lot of attention to sustainable development and corporate social responsibility, therefor the company develops and shares the best economic, environmental and social practices. Around 15% of industrial investments are spent for the environmental protection; talented staff develop innovative technologies for further implementation at all plants of Lesaffre Group. Figure 7 presents the three key aims for environmental best practices.

Figure 7. Key objectives in environmental best practices (Lesaffre 2015a)

The social practices, like ensuring sustainable mobility and supporting educational infrastructure, are being developed in every region, where Lesaffre operates. For the company it is important point to create social link for education, health, training and

employment. Social practices pursue the goals like supporting, ensuring and contribution (Figure 8).

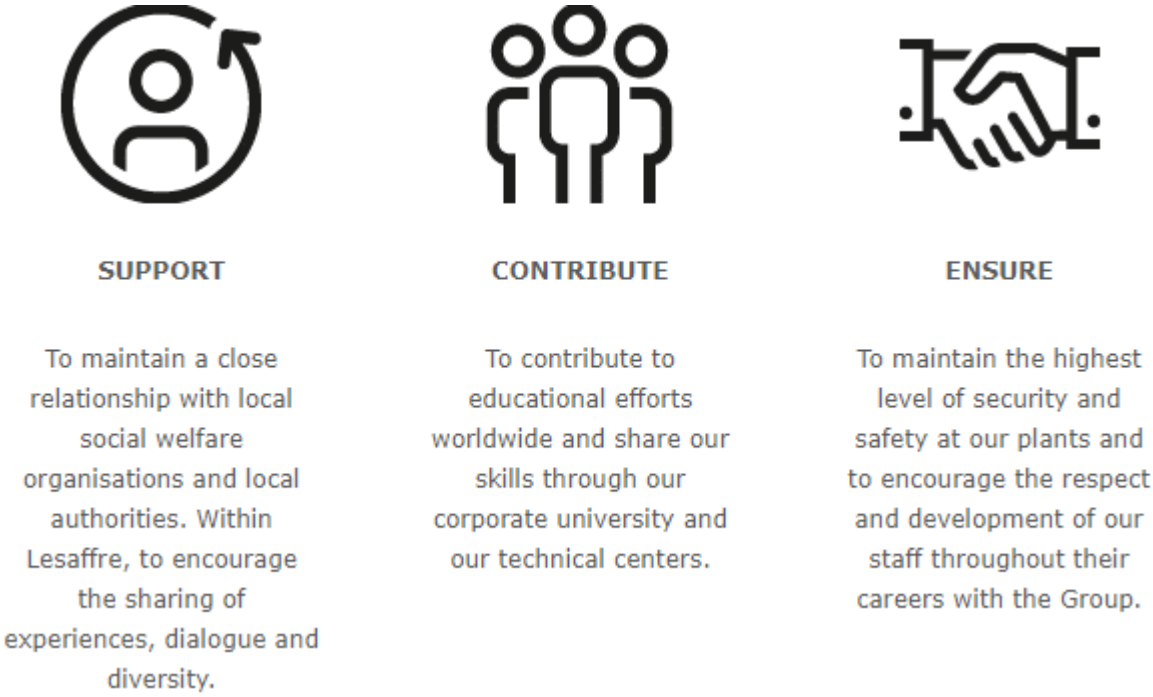


Figure 8. Key objectives in social best practices (Lesaffre 2015b)

Lesaffre also aims to operate in a responsible and ethical way to earn the trust of customers and stakeholders. The company also implement a continuous improvement strategy for contribution of costumers' economic performance.

3.1.2 Lesaffre's need for the evaporation unit technology

Due to changes and tightening of the Russian legislation, several years ago Uzlovaya yeast plant faced a problem with wastewater quality. It is worth noticing, that wastewater at the plant is weak vinasses which is a byproduct of yeast manufacturing process. Weak vinasses are a brown liquid with an unpleasant sour smell. Wastewater generated during the yeast manufacturing process has very low quality and did not comply with current legislation for further discharge into the city sewer. Low quality of water is explained by yeast production features. It entailed permanent penalties in the framework of environmental legislation. Another aspect was related to bad smell of strange origin in the city and many complaints from residents. As it was mentioned before, Lesaffre focuses on environmental protection

and also considers social aspects in the regions, where plants operate. The situation went against the principles of the company, therefore there was decision making on water-treatment system construction. In 2011, the company spent about 30 million rubles to replace the 7 km sewer collector, which is now also used by residents of the nearby village. Moreover, additional permits from Rosprirodnadzor (the Federal Service for Supervision of Natural Resources) for all atmospheric emissions were obtained, and continuous monitoring of effluents is carried out. Lesaffre also funded over 8 million rubles to improve the quality of wastewater treatment and the reconstruction of biological treatment facilities. The next step was construction of evaporation unit as a local treatment facility at plant.

3.2 Wastewater treatment

As it was mentioned before, characteristics of wastewater before treatment at evaporation unit did not comply with Russian regulations, which lead to large penalties. Wastewater samples are taken on a quarterly basis. Concentrations of contaminants discharged into municipal sewer network determined from the data obtained during the observation period since 2010. The table 2 shows the initial averaged water quality indicators and established maximum permissible discharges (MPD) to municipal sewer network.

Table 2. Water characteristics before treatment

Substance's name	Qualitative indicators of sewage, mg/l		Excess ratio
	Average water quality	MPD	
1	2	3	4
Aluminium	0	3,00	-
Dry residue	**4850,89**	**3000,00**	**1,62**
BOD_5	**1327,59**	**300,00**	**4,43**
Petrolium products	3,32	10,00	-
COD	**710,00**	**500,00**	**1,42**
Chlorides	577,95	1000,00	-
Cuprum	0,02	0,50	-

Iron	**9,21**	**3,00**	**3,07**
Ammonium ions	**46,53**	**20,00**	**2,33**
Nickel	0,00	0,25	-
Phenols	0,00	0,25	-
Phosphates	**2,59**	**1,20**	**2,16**
Sulphates	**890,22**	**300,00**	**2,97**
Suspended solids	**691,44**	**300,00**	**2,30**
Surfactants	0,65	10,00	-
Formaldehydes	0,06	0,35	-

As it is seen from the table, exceeding the permissible discharges in the wastewater discharged into municipal sewer network is observed for the following substances:

- Dry residue, excess ration is 1.62;
- BOD_5, excess ratio is 4.43;
- COD, excess ratio is 1.42;
- Iron, excess ratio is 3.07;
- Ammonium ions, excess ratio is 2.33;
- Phosphates, excess ratio is 2.16;
- Sulphates, excess ratio is 2.97;
- Suspended solid, excess ratio is 2.30.

The main focus was on BOD, COD, dry residue, suspended solids, sulfates and iron. After establishing of evaporation unit a local water treatment facility, the plant was able to significantly improve water quality and also develop new products. Characteristics of treated water are presented in Table 3.

Table 3. Water characteristics after treatment

Substance's name	Qualitative indicators of sewage, mg/l		Excess ratio
	Average water quality	MPD	
1	2	3	4
Aluminium	0	3,00	-

Dry residue	2681,86	3000,00	-
BOD_5	290,00	300,00	-
Petrolium products	3,07	10,00	-
COD	405,00	500,00	-
Chlorides	377,14	1000,00	-
Cuprum	0,01	0,50	-
Iron	2,77	3,00	-
Ammonium ions	16,46	20,00	-
Nickel	0,00	0,25	-
Phenols	0,00	0,25	-
Phosphates	0,70	1,20	-
Sulphates	**671,00**	**300,00**	**2,24**
Suspended solids	176,00	300,00	-
Surfactants	0,20	10,00	-
Formaldehydes	0,08	0,35	-

Implementation of evaporation unit allows to remove effectively 7 out of 8 substances, which excesses were previously recorded. However, It is worth noticing, that there are still excesses for sulphates. This remark showed the necessity to analyze reasons, because evaporation unit technology had to prevent entering sulphates to treated water. Analysis showed, that high sulfates level were found in artesian water, which is supplied to the plant for manufacturing process. This excess is typical for Uzlovaya region and there is no negative impact on food safety, environment or people (Danilovich 2015). According to laboratory analysis, sulfates level fluctuates between 725,9 and 1180,19 mg/l. Therefore, it is possible to conclude, that evaporation unit is able to decrease sulfates level in water to 671 mg/l. Figure 9 shows difference between wastewater (weak vinasses) and treated water.

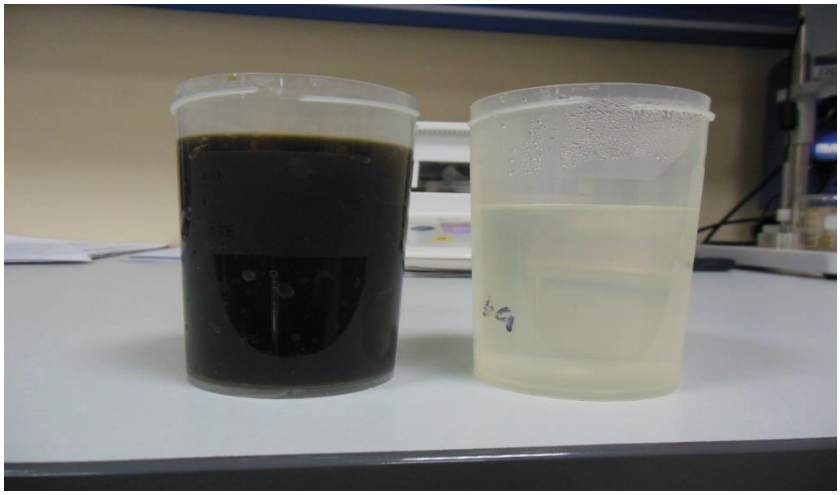


Figure 9. Weak vinasses as wastewater (left) and treated water (right)

It is worth noticing, that wastewater is characterized by a high content of non-biodegradable organic compounds (derivatives of beet molasses) and a high salt content. Therefore, biological treatment technology in this case is not effective. In addition, its appreciation is undesirable due to the specifics of manufacturing, which implies a high degree of bacterial purity in the production in order to avoid disruption of the technological process. On the territory of a yeast plant, the use of other biological processes, especially those that contain uncontrolled biomass, is highly unacceptable. Another possible alterative could be membranes and reverse osmosis. However, there is a high risk of membrane failure due to crystallization of mineral salts, as well as membrane fouling with organic dissolved substances.

3.3 Working principle: evaporation unit

The evaporation unit was established to treat wastewater and to concentrate the weak vinasses after the separation of the yeast fraction at the outlet of the fermenters. In addition to water treatment, evaporation unit allows to produce new products such as fertilizers. The unit is also coupled with a crystallization unit to be able to produce together another kind of products – feed additives for livestock.

The evaporation unit consists of:

- Vinasses tank: it used to store weak vinasses between fermentation and evaporator;
- A feeding pump to feed the evaporator;
- A heat exchanger for heating the weak vinasses and cooling condensate;
- Two falling film evaporator (4th effect and 3rd effect);
- Two forced circulation evaporator (2nd effect and 1st effect);
- Vinasses flash tank before crystallization for cooling the vinasses before crystallization;
- A forced circulation evaporator effect 1' after crystallization;
- A vinasses flash tank before crystallization for cooling the vinasses before decanting machine;
- Vacuum system for making vacuum on the unit;
- Cooling tower;
- CIP (cleaning in place) tank and CIP pump: for preparation of CIP solution and cleaning of the unit;
- Service water.

The evaporation part is constituted in fact of two evaporators working together: one before the crystallization and the other one after the crystallization (the finisher). The first evaporator is a four effects evaporator, composed of two forced circulation evaporators, and two falling film evaporators. It's a counter flow evaporator, what means that the weak vinasses is sent the 4th effect, gone to the 3rd effect, then to the 2nd and finally to the 1st effect. It means that the 1st effect is more concentrated in comparison with the 4th one. The steam is sent to the 1st effect, then to the 2nd, the 3rd, the 4th ones and finally to the condenser.
The vinasses after 1st effect is sent either to crystallization unit (and then to effect 1') or directly to effect 1'. The effect 1' is heated by the steam. The vapor coming from the effect 1' goes to the 2nd effect of the main evaporation unit (Appendix 1).

3.3.1 4th and 3rd effects

The effect 4 is a falling film evaporator. The pump provides circulation of the evaporated liquid inside the effect., and it is used to bring the vinasses on the top of the evaporator. The vinasses go down along the tubes inside, but outside of the tubes the hotter vapor is

condensed. The energy from the condensation of the vapor is transferred to the vinasses and a part of the vinasses is evaporated. At the bottom, there is a mix of vinasses and vapor.

The evaporator is composed in 2 parts - the separator and the tubular exchanger. The separator is used to split the vapor from the vinasses. A bigger separator decreases the risk of foaming. Inside the separator, there is a demister, this one is used to stop all water drops, which can contain some particles. The aim is to improve the quality of the condensate. The second part is the tubular exchanger where the heat exchange is carried out between vapor and vinasses. The falling film evaporator is applied for liquids with quite low viscosity and density. Generally, the amount of solids fluctuates between 13 and 17%.

Then vinasses from 4th effect go to 3rd effect through the regulation valve. The 3rd effect is similar as the 4th effect.

3.3.2 2nd and 1st effect

After the 3rd effect, vinasses are transferred to 2nd effect. This effect is a forced circulation effect. The circulation of the vinasses is made with the circulation pump from the separator to the tubular exchanger. In the forced circulation exchanger, the speed of the vinasses is quite important to decrease clogging risk. In the falling film, evaporation was made inside the tubes of heat exchanger. But here, in forced circulation effect, vinasses are just heated, and evaporation is provided in separator.

Temperature at the inlet and outlet of the exchanger is used to control heating in the exchanger. When the heated vinasses go back to separator, a part of the vinasses is evaporated for temperature reduction. This vapor is slowed down in separator to avoid taking some particles with the vapor. Here again the separator is used to avoid foaming problem. In this separator, there is also a demister to stop water drops containing some particles and improve condensate quality. Then vinasses go to the 1st effect, which has the same working principle like as the 2nd one.

3.3.3 Flash tank

The aim of the flash tank is to decrease the temperature of the vinasses. The hot vinasses (around 85-95°C) go to the flash tank where the pressure is low. So the temperature of vinasses in the flash tank can decrease till around 45-55°C. The vapor produced in this flash tank, goes to the condenser to be cooled down. At the outlet of the flash tank the vinasses concentration is between 35% and 55% (this parameter is adjusted in dependence on needs). The unit is applied in "recycling mode", it means the outlet vinasses go back to the 2nd effect until it reaches the needed concentration. After that vinasses are transferred to crystallization, where potassium is removed from vinasses by cooling and adding special components.

Finally, the condensate formed during evaporation is used as process water for various installation needs. By means of a pump, condensate flows:
- on mechanical pump seals;
- filling various containers;
- preparation of CIP solutions;
- flushing.

3.3.4 Falling film and forced circulation evaporator.

The unit has falling film and forced circulation evaporator. The falling film evaporator is used for low concentration of weak vinasses. Concentration increase can lead to the clogging and at this step it's necessary to use a forced circulation evaporator.

The falling film evaporator is a vertical exchanger. The vinasses at the bottom of the exchanger are sent to the top of the evaporator with a help of circulation pump. Under the gravity force, the vinasses go to the bottom of the tubes (inside the tubes). The vinasses are split on all exchange tubes with some distribution plate. The aim is to send enough vinasses in each exchange tube to decrease clogging risk. Inside the tubes there is a thin layer of vinasses. Outside the tubes, there is some steam, which is hotter than the vinasses. Due to temperature difference between vinasses and steam, steam is condensated, and energy is transferred to the vinasses. Then the vinasses are evaporated.

At the bottom of tubes there is a mix of vinasses and vapor (the amount of vapor is very low, less than 5% of the circulation flow is evaporated). The vinasses go back to the circulation pump to be sent again to the top of the evaporator.

The vapor transfers through the separator to decrease its speed and decrease foaming risk. A demister is installed in the falling film evaporator to stop all drops of vinasses and improve condensate quality. Figure 10 shows the drawing of falling film evaporator.

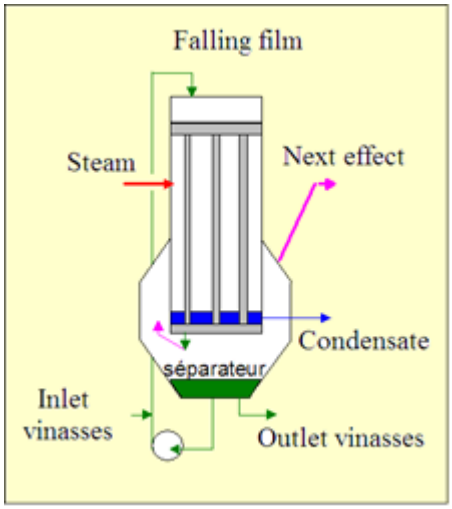


Figure 10. Falling film evaporator

The forced circulation evaporator is used on liquid with a higher concentration then in falling film. When viscosity, density and risk of crystallization becomes higher, this type of evaporator is applied (Figure 11).

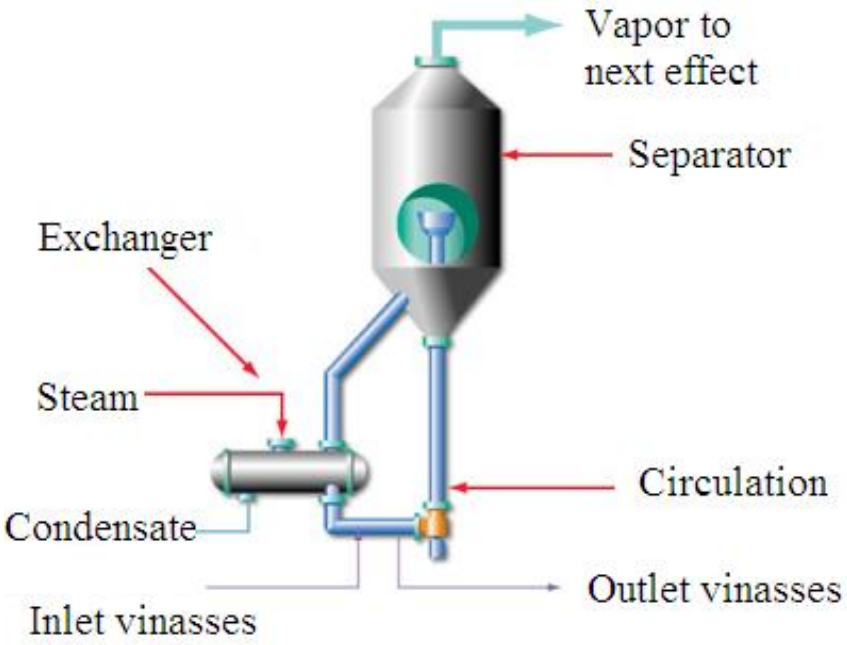
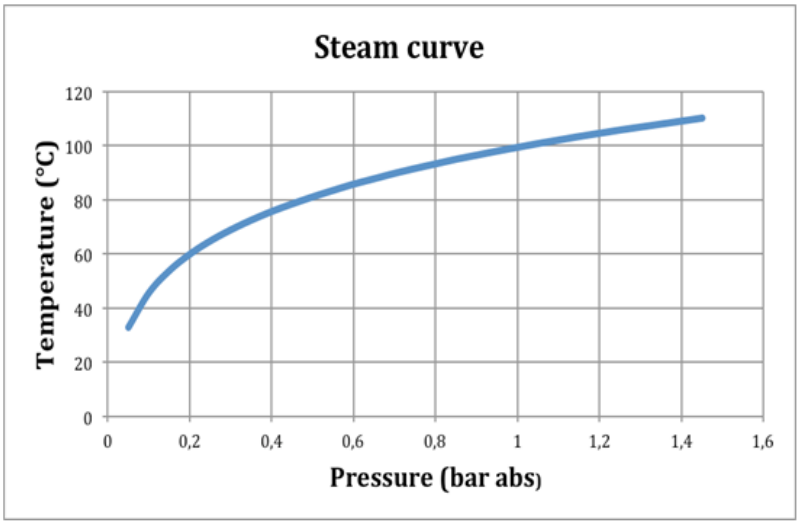


Figure 11. The forced circulation evaporator

This kind of exchangers is composed by a circulation flow with a high flow. The aim is to have enough speed in the tubes and prevent any deposition. The exchanger and the tubes are full of vinasses, it means there is no evaporation in the exchanger. Between the inlet and the outlet of the exchanger, the vinasses are just heated by 1 to 3°C, and then transferred back to the separator. When the warmed vinasses return to the separator with a temperature above the boiling point, part of the vinasses boil, cooling to a boiling point. The vapor produced is slow down again to decrease foaming risk.

Here it is important to pay attention on some physical terms. The water has a specific boiling temperature at a specific pressure (Figure 12). Here equivalent temperature at the pressure is defined as the normal temperature of saturated steam at this pressure. The weak vinasses contain many other components such as salts and etc. All these components increase the boiling point of the vinasses. This is called boiling point elevation (BPE).



Pressure (abs bar)	Temperature (°C)
0,05	33
0,1	45,8
0,15	54
0,2	60,1
0,25	65
0,3	69,1
0,35	72,7
0,4	75,9
0,45	78,7
0,5	81,3
0,55	83,7
0,6	86
0,65	88
0,7	90
0,75	91,8
0,8	93,5
0,85	95,2
0,9	96,7
0,95	98,2
1	99,6
1,05	101
1,1	102,3
1,15	103,6
1,2	104,8
1,25	106
1,3	107,1
1,35	108,2
1,4	109,3
1,45	110,4

Figure 12. Temperature of saturated steam according to the pressure

All components, contained in water, increase BPE. Water is the basis, thus it means water does not have BPE. In case of vinasses the higher BPE is, the higher vinasses concentration is. The weak vinasses have low BPE (around 0,3-1°C), but concentrated vinasses' BPE is closer to 9 – 12 °C.

The pressure between two effects (two evaporators) is the sum of the BPE and the DT (difference of temperature between steam and vinasses). Thus, for a given pressure difference, the lower BPE is, the higher effective temperature difference DT is (higher achievable capacity) (Figure 13).

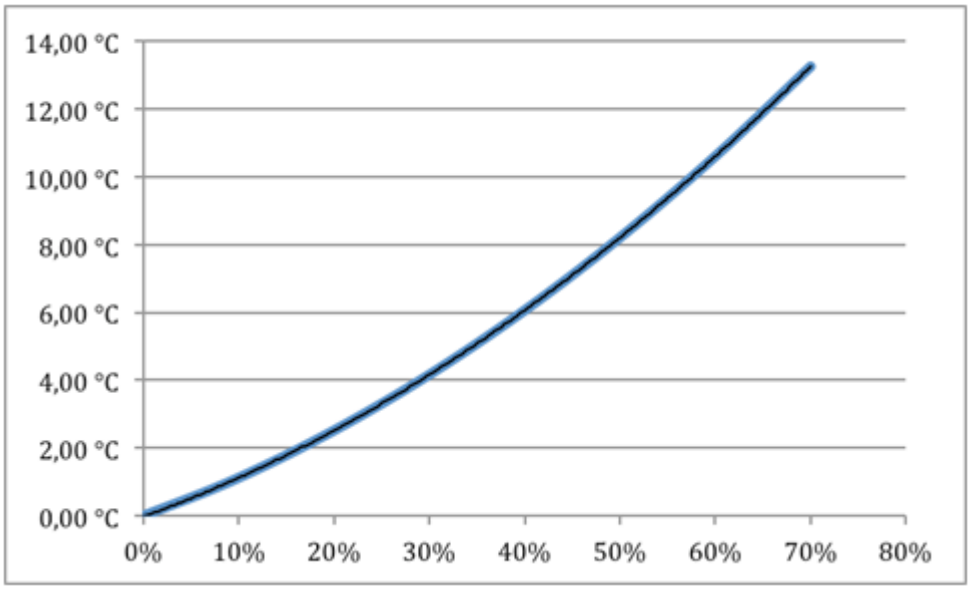


Figure 13. Example of increasing of BPE according to the concentration in dry solids

3.4 New products

In addition to treated water, evaporation unit allows to produce new products. They can be divided into two categories – fertilizers (like potassium extract, Fertil and Fertisaf) and feed additives for livestock (Safralic and Viprotal) (figure 14). Safralic and Viprotal is concentrated vinassa with high protein, calcium and phosphorus content, the first product is applied for pigs, another one is for cattle. Fertilizers are highly effective for various crops and, especially, requiring high potassium content for growth (sugar beets, potatoes, rape and others). Additionally, these fertilizers work as bio-stimulants that stimulate plant growth, increase the resistance of plants to adverse environmental influences, such as frost or drought, and also increase shelf life of fruits and vegetables. They are environmentally friendly fertilizers and registered in the countries of the EU as fertilizers approved for organic (ecological) farming.

Figure 14. Product examples: glasses - Safralic and Viprotal, dishes – potassium extract and Fertil.

Figure 15 demonstrates the closed circle of manufacturing process. Sugar beet is applied for sugar production and the by-product of manufacturing is molasses. Molasses are used as the main raw material for yeast production. After yeast manufacturing, weak vinasses are formed, and then it is used for production of fertilizers and feed additives. Finally, fertilizers from weak vinasses are applied for agriculture and also sugar beet cultivation.

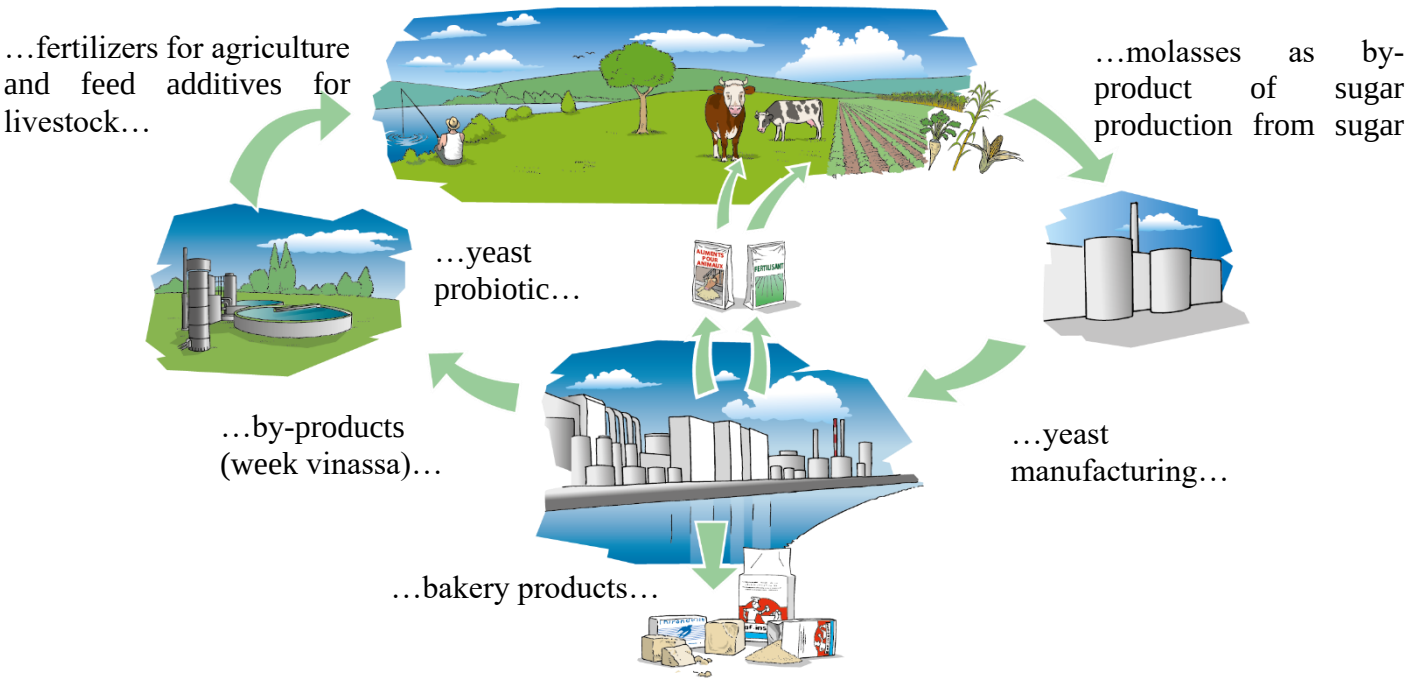


Figure 15. Lesaffre's example of circular economy implementation

It is worth noticing also, that Lesaffre takes responsibility on application of fertilizers into soil, that also simplifies the work of farmers, especially those who do not have specialized equipment. Thus, the company supports and develops the social component in the region of its presence.

3.5 Laboratory analysis for new product and methods

Quality of feed additives and fertilizers are very essential points in terms of animal and plant protection from different diseases, which can influence on human health. Thus, the company pay a lot of attention on laboratory methods and analyses on quality control of final products. All applied methods for analysis were developed by Lesaffre. There are two types of laboratory tests – express tests in the workshop where evaporation unit is placed and wide range of analysis provided in physic-chemical and microbiological laboratory of the company. Amount of tests and parameters depends on product type (fertilizer or feed additive).

Express tests for fertilizers are arranged every 2 or 3 hours and includes assessment of precipitation in the product and product's viscosity. Additionally, dry solids are analyzed several times per shift using infrared oven. In the physic-chemical laboratory, laboratory assistants tests and estimates solid matter content, potassium, nitrogen, sodium, pH, phosphorous and organoleptic parameters. In terms of feed additives, analyses consists of estimation of calcium, nitrogen, solid matter content, sodium, potassium, mass fraction of crude ash, phosphorus and mass fraction of crude protein. Additionally to the listed parameters, microbiological laboratory checks the presence of e.coli, salmonella and clastridium botulinum. These tests guarantee product safety and, as a consequence, human and animal health.

4 ASSESSMENT OF ENVIRONMENTAL, SOCIAL AND ECONOMIC SUSTAINABILITY

The main task of evaporation unit construction is complement the production cycle of yeast with further wastewater treatment from the yeast production. Project sustainability is based on three parts – social, environmental and economic.

Environmental impact includes arrangement of zero-waste yeast production, which significantly reduces the environmental load on city's treatment facilities, improve the wastewater quality and quality of treated water for reusing, and reduce the environmental impact from existing yeast production, thereby ensuring the ecological safety of the region. On the one hand, the evaporation unit allows to use natural resources in more efficiently, transfer waste into new commercial useful products. On the other hand, it helps to eliminate waste and, thus, reduce negative impact on environment. Water characteristics were described in chapter 3.3. The company also considered opportunity and availability for implementation biological wastewater treatment and membrane technologies. But according to investigations, these methods could be much less affective in comparison with evaporation unit. The problems could be related to membrane fouling and, more important, risk to current technological process of yeast production. The evaporation unit allows avoiding excesses in wastewater and even reducing sulfates level in 1.1-1.8 times in comparison with entering water quality parameters.

From the point of economic efficiency, evaporation unit helps to reduce environmental fees and penalties. The return on investment is justified by a decrease in annual payments for environmental pollution after launching of evaporation unit:

- reduction of wastewater processing costs - 6.8 million rubles per year;
- no annual fines for exceeding the maximum permissible concentration in wastewater - 6.7 million rubles per year.

The total cost savings after commissioning of evaporation unit equals around 13.5 million rubles per year. It is also worth noting, that given technology eliminates risks of suspension

of existing production, allows producing new products, treating water and also increase yeast production. According to internal calculations, the payback period of the investment project is 12 years. The payback period of an investment project is calculated from the day financing of the investment project begins until the day when the difference between the accumulated amount of net profit with depreciation and the amount of investment costs becomes positive.

Evaporation unit is also valuable due to its social impact. As far as evaporation unit is detached workshop, it is needed to create new working places for construction period and then for exploitation. The positive effect of job creation is expressed primarily in expanding employment, reducing unemployment, improving working conditions in the region. Another advantage, bad odor, that bothered citizens, disappeared.

All of the factors listed above give reason to consider this technology as relevant and viable, creating conditions for subsequent implementation at different manufacturing plants.

4.1 Possible improvements

One of the main criteria for the evaporation unit is energy efficiency. According to current situation, the workshop with evaporation unit is equipped with energy-saving lamps and double-glazed windows. Heat cogeneration unit was also installed at the plant. However, there is need and aim to decrease energy consumption and also decrease operational costs.

In future, energy efficiency can be improved through several actions. The first one is consideration of separate parts of current evaporation unit, which can be more energy efficient and also allow to increase power for greater flow of wastewater. This proposal is actual now because the plant produces more yeasts and there is direct influence on amount of wastewater. The second proposal is analyzing of insulation materials for the workshop and further possibility for changing current on effective heat-insulating materials. And the last action that can be considered for improvement is implementation of pre-evaporator and mechanical compression of the steam. Pre-evaporator utilizes low-level waste heat to evaporate weak liquor prior to the main evaporator. Mechanical compression of the steamtechnology allows the reuse of heat from steam due to mechanical compression. The

main advantage of the mechanical steam-compression systems is that the energy requirements of the volumetric compressor is lower than the steam production costs of multiple-effect evaporation systems.

Thus, it helps to reduce amount of needed steam at the evaporation unit, and hence decrease prime cost and cost of electricity.

5 DISCUSSION

Evaporation unit technology was developed and implemented at Lesaffre's plant in Uzlovaya. According to estimated economic, social and environmental efficiency, it is possible to say that the project is valuable and there are possibilities to apply the technology at other plant. It is worth noticing that the technology has to be combined with current production (e.g. chemical, mining, food processing, yeast production, pharmaceutical, textiles, fuel and oil etc). There is no possibility and need to implement it as an independent production. This solution can help decide problems related to volume reduction, concentration or wastewater treatment (France Evaporation 2019.).

In the chapter 2, different circular economy business models were described. Now it is possible to conclude, that Lesaffre's plant in Uzlovaya works under the principle of circular suppliers and resource recovery. Moreover, following aims were succefully reached:

1) ensure a zero-waste cycle of yeast production based on the complete utilization of weak vinasses, which are considered as raw materials for the production of fertilizers for agricultural purposes and feed additives for livestock;
2) creation of highly efficient, environmentally friendly production for manufacturing of import-substituting products, which contribute to the development of regional production forces and new technologies;
3) creation of new working places in the new workshop where evaporation unit is placed, further education of personnel for work at modern equipment and attractive of young specialists;
4) increase production and reduce the cost of agricultural products for local farmers by using by-product of yeast manufacturing as agricultural fertilizer and feed additives for livestock;
5) significantly reduce the environmental negative effect on city wastewater treatment plants and the level of the environmental impact of the plant and, therefore, improve the environmental safety of the region;

6) according to the decision of the local authorities, evaporation unit is related to technologies with great socio-economic importance to the government in terms of implementation circular economy at country level;
7) full compliance with Russian legislation aimed at preserving the environmental protection and reducing waste;
8) contribution to Sustainable development goals such as clean water and sanitation, sustainable cities and communities, responsible consumption and production;
9) starting of implementation circular economy at manufacturing processes.

However, one of the actual challenges for the company is energy consumption in the workshop with evaporation unit. The aim for several next yeas is its improvement. Possible improvements in terms of energy efficiency are presented in chapter 4.1.

6 CONCLUSION

In conditions of limited resources, the question of their rational use is very acute. Sustainable development and circular economy are closely related. Circular economy can help in achieving aim of Sustainable development. Therefore, it is implementation and substitution of linear economy model are necessary in the nearest future. Circular economy model consists of biological and technological cycles, which provides ensuring resource efficiency and the absence of waste. One of the most significant factors for circular economy implementation is financing. Circular economy can be promoted and implemented through government and corporations. Acording to Accenture there are 5 circular economy business models: circular suppliers, resource recovery, product life extension, sharing platforms, product as a service. Lesaffre LLC was chosen for demonstration of implementation circular economy into production cycle on the example of evaporation unit technology.

Evaporation unit is unique technology in Russia. Lesaffre's experience shows possibility for further development and implementation of this technology at other plants in pharmaceutical, yeasts, chemical and other productions. This evaporation unit is valuable from economic, social and environmental points of view. It uses wastewater as raw materials for producing new products and water treatment with possibility for further use inside the plant. Moreover, such technologies have a potential for contribution to reach sustainable development goals in terms of water treatment and consumption, responsible production and consumption.

For further application of circular economy, government support, changes in legislation all over the world are needed as well as development of supporting guidelines, technologies and instruments for wide application in different fields. Another significant contribution is related to corporations' commitment and involvement into circular economy transition. It can be reached by application of different circular economy business models and implementation of own sustainable initiatives.

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Scheme of evaporation system