# BBChina

*Master Program on Bio-Based Circular Economy*

# Equipment

**Project ID Number: 586083-EPP-1-2017-1-IT-EPPKA2-CBHE-JP**

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## Lab Equipment

The list of the equipment purchased within the Project implementation is the following:

1. Equipment for practical advanced lab-training
2. Equipment for practical basic lab-training
3. Software (i.e. simulation software)
4. PCs and accessories to be used as host of the e-learning platform
5. E-learning environment tools
6. Textbooks

The evaluation "ex ante" done at the project proposal submission stage pointed out the need, in order to support the best implementation of the project, to improve the educational labs structure of the three Chinese HEIs, with also the specific aim to support the implementation of a **common educational lab structure** all over the three institutions. In fact, the aim of the proposed action regarding practical lab experience for the Master Program students is stated in the project proposal (Work Package 3 description): "Lab equipment will be implemented **on a homogeneous basis, in order to allow a common practice for the students**." This is further explained in the "Work Package and Outcome ref.nr 3.7" stating "(...) the target of this sub task is to coordinate the organisation of a lab platform **homogeneous** in between the three different HEIs, which is not presently the status. As a matter of example, lab facilities at TJU are especially targeting in the field of waste, wastewater and air pollution control, while at ECUST and SCU they are more oriented to chemical and physical analysis for biofuels and biochemicals."

Following the Proposed Project Workplan, the first step of the action was the development of the Master Program Syllabus including the titles of the Courses (that are in common between the three Chinese HEIs) specifically related to the Master Program. Once the Syllabus was defined, the syllabus of each course has been defined and several lab activities have been planned for most of the BBChina courses. The lab equipment necessary for the planned lab activities related to each course was then pointed out. It was then built a table with the necessary lab equipment **in common** for the three Chinese HEIs and then checked which lab tool was available or missing in each Institution.

The tables for advanced and basic lab training used during the elaboration of the common lab structure are attached below (*Table 1* and *Table 2*). In these Tables, the missing lab instruments (identified by a unique ID) that were purchased through the BBChina project are pointed out **in bold** on white background. The already available tools are in the cells with a grey background.

| **Lab instrument purchased under BBChina** | Lab instrument/tool already available |
|---|---|

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A detailed document pointing out the courses where each instrument will be used for the practical educational lab activities (and the kind of lab activity), was already sent for information to the project officer in June 2019.

The same has been done for the Software tools, where an evaluation of the necessary software to support Lab activities for the Master Program Students was pointed out, and the software “Compound Discoverer” has been chosen.

The Chinese HEIs finalised the purchase for the planned educational equipment/tools, following the mandatory tendering procedures described in the Guidelines (3.2.5 Award of Contracts and Tendering procedure).

The column “RELATED COURSES” indicates the IDs (see *Table 3*) of the courses where the instrument will be used for the practical educational lab activities.

Furthermore (*Table 4*), a set of planned lab activity examples are presented for the BBChina courses that foresee Lab Experiences, and for each of these lab activities, the involved equipment is pointed out.

Legend for the Chinese HEIs:

**TJU**: Tongji University (PIC: 997863736)

**ECUST**: East China University of Science and Technology (PIC: 997351382)

**SCU**: Sichuan University (PIC: 998311779)

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| ***Advanced Lab Equipment ID*** | **TJU** | **ECUST** | **SCU** | **RELATED COURSES** |
|---|---|---|---|---|
| **A1** | Gas chromatography | Gas chromatography | Gas chromatography | 01; 02; 03; 04; 05; 06; 07; 11; 12 |
| **A2** | **Gas analyzer** | Gas analyzer | Gas analyzer | 01; 03; 04; 06; 07; 11; 12 |
| **A3** | Spectrometer | Spectrometer | Spectrometer | 01; 02; 03; 04; 06; 07; 11; 12 |
| **A4** | BET analyzer | **BET analyzer (*including necessary Spare Operators*)** | BET analyzer | 01; 03; 04; 06; 07; 11; 12 |
| **A5** | ICP | ICP | ICP | 01; 02; 03; 04; 06; 07; 11; 12 |
| **A6** | Scanning Electron Microscope (SEM) | Scanning Electron Microscope (SEM) | **Scanning Electron Microscope (SEM)**<br>***An additional Critical Point Dryer as an Accessory, to upgrade to the other HEIs level (*)*** | 01; 02; 03; 04; 05; 06; 07; 11; 12 |

***Table 1: Advanced Lab Structure with available and missing equipment;***
***(*) SCU purchased a Critical Point Dryer (already available at TJU and ECUST) to meet the requirements of plant SEM (already available at SCU) sample preparation. Morphological observation is an important content and skill of plant development biology study and research.***

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| *Basic lab equipment ID* | TJU | ECUST | SCU | RELATED COURSES |
|---|---|---|---|---|
| **B1** | Mass flowmeters | **Mass flowmeters** | Mass flowmeters | 01; 03; 04; 05; 06; 07; 11; 12 |
| **B2** | Electronic balance | **Electronic balance** | Electronic balance | 01; 02; 03; 04; 05; 06; 07; 11; 12 |
| **B3** | Metering pump | **Metering pump** | Metering pump | 01; 02; 03; 04; 06; 07; 11; 12 |
| **B4** | Fluorescent Analyser | Fluorescent Analyser | **Fluorescent Analyser** | 01; 02; 03; 05; 06; 07; 11; 12 |
| **B5** | **Incubator** | **Incubator** | Incubator | 05; 06; 07 |
| **B6** | Vacuum moisture-proof chamber | Vacuum moisture-proof chamber | **Vacuum moisture-proof chamber** | 03; 04; 06; 07; 11; 12 |
| **B7** | Parallel High Pressure Reactor (Autoclave) | Parallel High Pressure Reactor (Autoclave) | **Parallel High Pressure Reactor (Autoclave)** | 03; 04; 06; 07; 12 |
| **B8** | Chemical reagent locker | Chemical reagent locker | **Chemical reagent locker** | All the courses except 08; 09; 10 |
| **B9** | Upright Ultra Low Temperature Freezer | Upright Ultra Low Temperature Freezer | **Upright Ultra Low Temperature Freezer** | 03; 06; 07; 11; 12 |

*Table 2: Basic Lab Structure with available and missing equipment*

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| BBChina Courses | | | |
|---|---|---|---|
| **ID** | **Course Title** | **ID** | **Course Title** |
| 01 | Integrated Solid Waste Management | 07 | Chemistry of carbohydrates |
| 02 | Wastewater Treatment: Theory and Technology | 08 | Renewable Energy Technologies |
| 03 | Bioreactor Engineering | 09 | Bioeconomy, Energy Market and Green Market |
| 04 | Biomass process engineering for Bioenergy Production | 10 | Life Cycle Assessment |
| 05 | Plant development biology | 11 | Combustion |
| 06 | Biomass Energy: Technology and Application | 12 | Thermal Waste management and WtE technologies |

*Table 3: IDs of the BBChina Courses*

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| ID | Course Title | Example of educational lab activities to be performed and related tool from the lab equipment list |
|---|---|---|
| 01 | Integrated Solid Waste Management | "*Characterization of gaseous, liquid, oily, solid products during waste treatment (chemical, biological, thermal)*" using:<br>• gas chromatography **[A1]**,<br>• gas analyzer **[A2]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2],**<br>• Chemical reagent locker **[B8].**<br>Other Lab Activities will make use of<br>• metering pump **[B3]**,<br>• fluorescent analyser **[B4].** |
| 02 | Wastewater Treatment: Theory and Technology | "*Wastewater quality analysis*" using:<br>• gas chromatography **[A1]**,<br>• spectrometer **[A3]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• electronic balance **[B2],**<br>• metering pump **[B3]**,<br>• fluorescent analyser **[B4],**<br>• Chemical reagent locker **[B8]**. |

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| | | |
|---|---|---|
| 03 | Bioreactor Engineering | "*Characterization of the biomass material and the product using bioreactor*" using:<br>• gas chromatography **[A1]**,<br>• gas analyzer **[A2]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• electronic balance **[B2]**,<br>• Fluorescent Analyser **[B4]**.<br>"*The conduction of reaction*" using<br>• Mass flowmeter **[B1]**,<br>• Metering pump **[B3]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**,<br>• Chemical reagent locker **[B8],**<br>• Upright Ultra Low Temperature Freezer **[B9]**. |

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| | | |
|---|---|---|
| 04 | Biomass process engineering for Bioenergy Production | "*The characterization of the raw biomass material, the biofuel and the fermentation gas*" using:<br>• gas chromatography **[A1]**,<br>• gas analyzer **[A2]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• electronic balance **[B2]**,<br>• Fluorescent Analyser **[B4]**,<br>• Incubator **[B5],**<br>• Chemical reagent locker **[B8]**.<br>"*Pre-treatment of biomass material*" using:<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>"*Bioenergy production*" using:<br>• Mass flowmeter **[B1]**,<br>• Metering pump **[B3]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**. |
| 05 | Plant development biology | "*Observation of different developmental stages of model plants*" using:<br>• SEM **[A6]**,<br>• electronic balance **[B2]**,<br>• Fluorescent Analyser **[B4]**,<br>• Chemical reagent locker **[B8]**.<br>"*Gene expression changes during plant differentiation*" using:<br>• Fluorescent Analyser **[B4]**,<br>• Chemical reagent locker **[B8]**.<br>Other Lab Activities will make use of<br>• gas chromatography **[A1]**,<br>• Incubator **[B5]**. |

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| | | |
|---|---|---|
| 06 | Biomass Energy: Technology and Application | "*Lab production of biodiesel*" using:<br>• gas chromatography **[A1]**,<br>• ICP **[A5]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2]**,<br>• Metering pump **[B3]**,<br>• Fluorescent Analyser **[B4]**,<br>• Incubator **[B5]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**,<br>• Chemical reagent locker **[B8]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>"*Kraft Lignin Decomposition into Aromatic Monomers in Ethanol*" using:<br>• gas chromatography **[A1]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• SEM **[A6]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2]**,<br>• Incubator **[B5]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**,<br>• Chemical reagent locker **[B8]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>"*Hydrolysis of Mechanically Pretreated Cellulose in Water/$CO_2$ System*" using<br>• gas chromatography **[A1]**,<br>• spectrometer **[A3]**,<br>• ICP **[A5]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2]**,<br>• Metering pump **[B3]**,<br>• Fluorescent Analyser **[B4]**,<br>• Incubator **[B5]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**, |

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| | | |
|---|---|---|
| | | • Chemical reagent locker **[B8]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>Other Lab Activities will make use of<br>• gas analyzer **[A2]**, |
| 07 | Chemistry of carbohydrates | "*Production of 5-hydroxymethylfurfural from hexose*" using<br>• gas chromatography **[A1]**,<br>• spectrometer **[A3]**,<br>• ICP **[A5]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2]**,<br>• Metering pump **[B3]**,<br>• Incubator **[B5]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**,<br>• Chemical reagent locker **[B8]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>"*Chemicals from the cellulose conversion*" using<br>• gas chromatography **[A1]**,<br>• spectrometer **[A3]**,<br>• electronic balance **[B2]**,<br>• Fluorescent Analyser **[B4]**,<br>• Incubator **[B5]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Parallel High Pressure Reactor (Autoclave) **[B7]**,<br>• Chemical reagent locker **[B8]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**.<br>Other Lab Activities will make use of<br>• gas analyzer **[A2]**,<br>• BET analyzer **[A4]**,<br>• SEM **[A6]**. |

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| | | |
|---|---|---|
| 08 | Renewable Energy Technologies | No Lab Activity Foreseen |
| 09 | Bioeconomy, Energy Market and Green Market | No Lab Activity Foreseen |
| 10 | Life Cycle Assessment | No Lab Activity Foreseen |
| 11 | Combustion | "*Characterization of feeding material, flue gas, and solid residues during combustion*" using<br>• gas chromatography **[A1]**,<br>• gas analyzer **[A2]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2],**<br>• Chemical reagent locker **[B8]**.<br>Other Lab Activities will make use of<br>• metering pump **[B3]**,<br>• Fluorescent Analyser **[B4]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**. |

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| | | |
|---|---|---|
| 12 | Thermal Waste management and WtE technologies | "*Characterization of gaseous, liquid, oily, solid products during waste thermal treatment*" using<br>• gas chromatography **[A1]**,<br>• gas analyzer **[A2]**,<br>• spectrometer **[A3]**,<br>• BET analyzer **[A4]**,<br>• ICP **[A5]**,<br>• SEM **[A6]**,<br>• Mass flowmeter **[B1]**,<br>• electronic balance **[B2],**<br>• Parallel High Pressure Reactor (Autoclave) **[B7],**<br>• Chemical reagent locker **[B8]**.<br>Other Lab Activities will make use of<br>• metering pump **[B3]**,<br>• Fluorescent Analyser **[B4]**,<br>• Vacuum moisture-proof chamber **[B6]**,<br>• Upright Ultra Low Temperature Freezer **[B9]**. |

***Table 4: Lab activities per BBChina Course and related equipment***

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## Software

The software *"compound discoverer"* was purchased by TJU. It is used for practical advanced lab-training, such as identification of dissolved organic matter molecules in leachate.

The software utilisation has been shared with ECUST and SCU, and thus made available for all the BBChina students, to allow the better use of the available budget.


Hands-on lesson using the software *"compound discoverer"*

The software is used as support to the Lab activities of courses 01, 02, 03, 04, 07, 11, and 12 of Table 3.

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## Other Equipment

| TJU | ECUST | SCU |
|---|---|---|
| PCs and accessories to be used as host of the e-learning platform<br>• All-in-one PC | PCs and accessories to be used as host of the e-learning platform<br>• All-in-one PC | PCs and accessories to be used as host of the e-learning platform<br>• Server<br>• laptop |
| E-learning environment tools<br>• Projector<br>• Teaching Touchscreen TV<br>• Web Camera<br>• Wireless MIC<br>• Cabinet for Teaching Equipment | E-learning environment tools<br>• Projector<br>• Teaching Touchscreen TV<br>• Web Camera<br>• Wireless MIC<br>• Cabinet for Teaching Equipment | E-learning environment tools |

*Table 5: Other equipment purchased*

The set-up of a common platform for e-learning activities was necessary for sharing the lessons of the developed BBChina Courses.

The equipment purchased for this issue under the BBChina project is summarised in Table 5.

## Textbooks

Textbooks where purchased to support the courses activities. The purchased book list is presented here below

**Tongji University**

The University library already had the Books suggested by the partnership, therefore no books have been purchased.

**ECUST**

- The following books were purchased:

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Mehryar Mohri,Afshin Rostamizadeh, Ameet Talwalkar. Foundations of Machine Learning, The MIT Press; second edition, (2018).

- Trevor Hastie,Robert Tibshirani,Jerome Friedman. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer; 2nd (2016).
- Ian Goodfellow,Yoshua Bengio,Aaron Courville Deep Learning, The MIT Press (2016).
- Joseph L. Rose. Ultrasonic Guided Waves in Solid Media. Cambridge University Press, (2014).
- Auld, B. A. Acoustic Fields and Waves in Solids. 2nd Edition, Volumes I and II, Krieger Publishing Company, (1990).
- Gerard V. Smith & Ferenc Notheisz, Heterogeneous Catalysis in Organic Chemistry. Elsevier, (2000).
- Dacid B, Willliams & C. Barry Carter, Transmission Electron Microscopy: A textbook for Materials Science. Springer, (2004).

R. Morris Bullock, Catalysis without Precious Metals. Wiley-VCH, (2010)

**Sichuan University**

The following book was purchased: Mechanisms in Plant Development, Ottoline Leyser & Stephen Day, Blackwell Publishing Ltd, 2003

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## Labelling with EU EACEA Stickers

As from art. 3.2.6.1 (Equipment) of the Guidelines for the use of the grant, "All equipment purchased with the Erasmus+ CBHE funds must bear an Erasmus+ sticker to be printed or bought by the beneficiaries.".

Each hardware equipment purchased under the BBChina project was labelled with a bilingual (English and Chinese) sticker stating that the Equipment purchase was supported by the EU Commission, and that "The European Commission support for the purchase of this equipment does not constitute an endorsement of its use. The European Commission cannot be held responsible for any use that may be made of this equipment."

An example of the used stickers is presented in the following pictures.


***Example of bilingual stickers used for the equipment***

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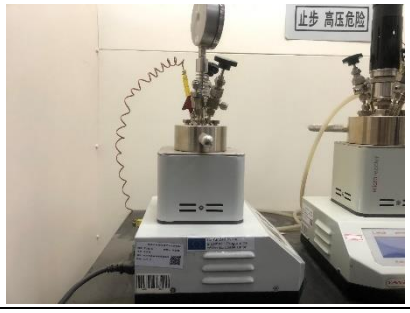
## Lab equipment installation and use

In the next pages, some photos of the installed equipment, and their use.

| | |
|---|---|
|  |  |
| *Incubator at Tongji University* | *Gas Analyser at Tongji University* |

| | | |
|---|---|---|
|  |  |  |
| *Ultra low temperature freezer at Sichuan University* | *Autoclave at Sichuan University* | *Critical Point Dryer at Sichuan University* |

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*Mass flow indicator and mass flow controller installed at ECUST*


*Cabinet at Sichuan University*


*Fluorescent Inverted microscope at Sichuan University*

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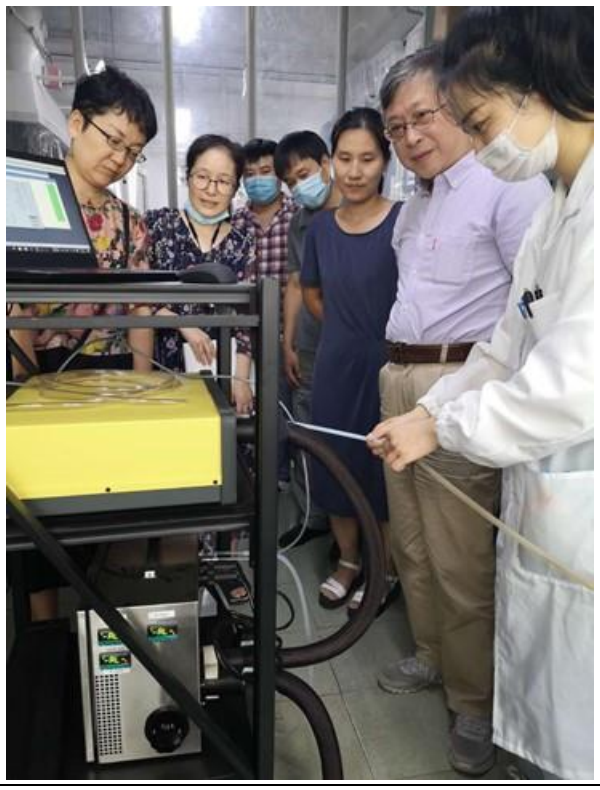
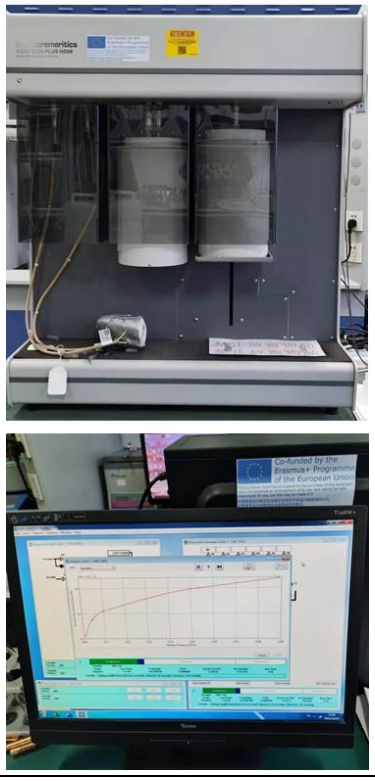


*The gas analyzer installed in the Tongji BBChina lab at College of Environmental Science and Engineering; used for practical advanced lab-training, such as analysis of flue gas composition.*



*Micropore Automatic Physisorption Analyzer and computer for control, installed Room 207, Lab Building 17# of ECUST. Used to analyse the pore size distribution and the specific surface area of the materials, such as activated carbons.*

*Cabinet for Teaching Equipment at Tongji University and distance learning activities*

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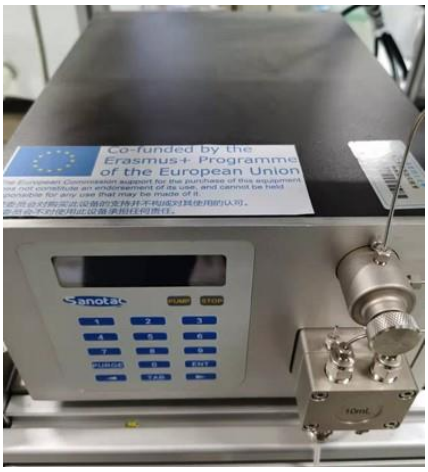
| | | |
|---|---|---|
|  |  |  |
| *Pump used to control the flow rate of the liquid in the experiments of the course 'Biomass process engineering for Bioenergy Production'* | *Software Compound Discoverer* | *Work station used to simulate the flow field and concentration distribution in the bioreactor* |

| | | | |
|---|---|---|---|
|  |  |  |  |
| *Equipment for distance learning at Tongji: All in one PC, Projector, Web Camera, and Microphone* | | | |

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