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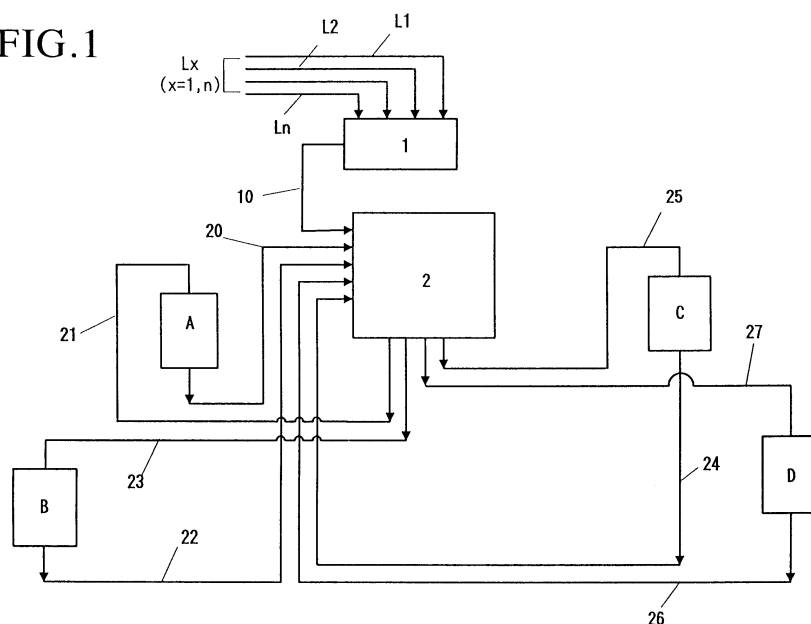
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(54) Improved multi-purpose production system and multi-purpose production method making use of the same

(57) An improved multi-purpose production system comprising a group of N batch process facilities, N outlet extending from bottoms of the respective process facilities, N inlet pipes extending from tops of the respective process facilities, an M:K automatic pipe connection (2), and an L:1 automatic pipe connection (1). The N outlet pipes and N inlet pipes, which extend from the tops and bottoms of the respective process facilities, are connect-

ed to corresponding inlet pipes and outlet pipes of the M:K automatic pipe connection. Further, a remaining inlet pipe (10) or desired one of remaining inlet pipes of the M:K automatic pipe connection and the single outlet pipe of the L:1 automatic pipe connection are connected together. L, K and M are desired integers indicating the numbers of the corresponding pipes, N stands for a desired integer indicating the number of the process facilities, $M \geq N+1$, and $K \geq N$.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention:

[0001] This invention relates to an improved multi-purpose production system and also to a multi-purpose production method making use of the same.

2. Description of the Related Art:

[0002] For batchwise production of intermediates or original drugs of drugs, fine chemicals or the like (hereinafter called "drugs or the like") in production fields of drugs or the like, it has been the conventional practice to arrange, exclusively for each product brand to be produced, a reaction vessel, an extraction vessel, a distillation tower, a crystallization vessel and the like and also fixed pipes therefor. In such a batchwise production system, transfer of fluids such as raw materials, product and like has been conducted primarily by selectively operating valves of the fixed pipes. An increase in the number of towers, tanks and/or the like (which may hereinafter be collectively called "process facilities") such as reaction vessels, however, leads to the need for a greater number of valves, unavoidably resulting in a more complex control system for the valves.

[0003] Wherever a need arises for the change-over of products from one product to another as a result of an increase in product brands, it has been necessary not only to modify an existing production plant, including arrangement of additional piping, but also to consider redesign of a control system, including prevention of mixing of foreign fluid or fluids.

[0004] Under the foregoing background, the present applicant have already proposed in JP 8-12000 B a flexible automatic pipe connection suitable for use in a hose station, said apparatus making combined use of plural groups of hoses employed in a batchwise production system in place of fixed pipes and being adapted to transfer raw materials, final product, intermediate products and the like, and also a control system therefor. In this patent publication, the automatic pipe connection comprises a unit with plural cells arranged in a vertical row in a plane, another unit with plural cells arranged in a horizontal row in a plane, movable carriers arranged for movements through the cells of the respective units, two groups of hoses connected at one ends thereof with corresponding pipings and at opposite ends thereof with couplers arranged in the movable carriers of the corresponding units, means arranged in association with the respective units to cause the corresponding movable carriers to move in the corresponding cells and to place the movable carriers at predetermined positions, respectively, and a device for causing the units or the couplers to move such that the proximal end of desired one of the hoses in one of the groups of hoses and that of

desired one of the hoses in the other group of hoses are brought into connection with each other and subsequent to completion of transfer of a fluid, their connection is cancelled.

[0005] The present applicant have also proposed in JP 8-25600 B a flexible automatic pipe connection for a change-over station, said apparatus permitting use of pipes led by stainless steel pipes instead of the hoses disclosed in JP 8-12000 B, and a control system for the apparatus. Needless to say, the pipes can be internally washed in these two proposals.

[0006] Further, the above two proposals are each accompanied by a potential problem in that in the unit with the cells arranged in the vertical row, the hoses may be bent at slack portions thereof, resulting in occurrence of liquid holdup or stagnation. As means for preventing mixing of a foreign fluid which may take place upon change-over of pipe connection, the present applicant have also proposed in JP 7-71699 A an automatic pipe connection for a change-over station, which does not form the above-mentioned liquid holdup or stagnation. These automatic pipe connections, each of which is provided with M inlet pipelines couplers and K outlet pipelines couplers, will hereinafter be collectively called "M: K automatic pipe connections".

[0007] As has been described above although not necessarily bound thereto, an application of one of the automatic pipe connection already proposed by the present application to a plant, in which towers and vessels permitting different unit operations such as reaction vessel, extraction vessel, distillation tower and crystallization vessel are used in an order determined in accordance with their functions, no longer requires intricate layout of pipes owing to the arrangement of the hose or pipe change-over station in place of fixed pipes and further, has made it possible to achieve inter alia a reduction in manual work, a substantial decrease in hazardous manual work, and prevention of mixing of a foreign fluid which would otherwise occur upon change-over of pipe connection.

[0008] The development of the above-described automatic pipe connections has led to further desires to use an existing plant or a newly-built plant for multiple purposes. As an example of such desires, concurrent production of different products in the same plant, in other words, so-called small-lot variety production can be mentioned. As another example, possible maximum reductions in downtimes of process facilities arranged in the same plant, in other words, their full operation to increase the production per unit operation time or to shorten the operation time for the production of the same single product can be mentioned.

[0009] However, the above-described proposals of the present applicant, when applied by themselves, are unable to meet the above desires at the same time.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is therefore to provide a multi-purpose production system permitting not only production of a single product with high efficiency but also small-lot variety production with high efficiency.

[0011] Another object of the present invention is to provide a multi-purpose production method making use of the plant.

[0012] With the foregoing circumstances in view, the present inventors have proceeded with an extensive investigation for means capable of achieving the above-described desires at the same time. As a result, it has been found that the above-described objects can be achieved by an improved multi-purpose plant comprising an L:1 automatic pipe connection having L fluid inlet pipes adapted to supply raw materials therethrough and a single outlet pipe, an M:K automatic pipe connection having M fluid inlet pipes and K outlet pipes, and a group of process facilities composed of N batch process facilities provided with a single inlet pipe and a single outlet pipe and having at least plural functions in common, a group of process facilities composed of N batch process facilities having plural different functions, or a group of process facilities composed of N batch process facilities having different functions, wherein N outlet pipes extending from bottoms of the respective process facilities in the group of process facilities and M inlet pipes extending from tops of the respective process facilities in the group of process facilities are connected with said the M:K automatic pipe connection, and one of the inlet pipes of the M:K automatic pipe connection and the outlet pipe of the L:1 automatic pipe connection are connected. It is to be noted that L, K and M are desired integers indicating the numbers of the corresponding pipes, N stands for an integer indicating the number of the process facilities, $M \geq N+1$, and $K \geq N$.

[0013] Therefore, the present invention provides an improved multi-purpose production plant comprising:

a group of N batch process facilities each of which is provided with a single outlet pipe extending from a bottom thereof and also with a single inlet pipe extending from a top thereof,
an M:K automatic pipe connection having M inlet pipes and K outlet pipes, and
an L:1 automatic pipe connection having L inlet pipes and a single outlet pipe;

wherein the N outlet pipes of the individual process facilities in the group and the N inlet pipes of the individual process facilities in the group are connected to desired ones of the inlet pipes and desired ones of outlet pipes of the M:K automatic pipe connection, respectively, and

a remaining inlet pipe or desired one of remaining inlet pipes of the M:K automatic pipe connection and the

single outlet pipe of the L:1 automatic pipe connection are connected together, in which L, K and M are desired integers indicating the numbers of the corresponding pipes, N stands for an integer indicating the number of the process facilities, $M \geq N+1$, and $K \geq N$.

In the group of process facilities, plural process facilities may have the same function, or may have different plural functions. The individual process facilities may have different functions.

[0014] The present invention also provides an improved multi-purpose production method, which comprises:

using a multi-purpose production plant as defined above;
conducting a unit operation in one of the process facilities;
changing over the M:K automatic pipe connection to transfer contents of the one process facility to another one of the process facilities; and
conducting another unit operation in the one process facility.

BRIEF DESCRIPTION OF THE DRAWING

[0015] The accompanying sole drawing, FIG. 1, is a flow sheet for describing an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] The present invention will hereinafter be described with reference to FIG. 1. Needless to say, it is to be noted that the present invention shall not be limited only to the embodiment of the drawing.

[0017] A description will be made about an L:1 automatic pipe connection 1 and an M:K automatic pipe connection 2, the former of which is provided with plural pipes for supplying raw materials, washing water, solvent and the like.

[0018] A pipe group L_x consisting of n pipes L₁-L_n is connected to an inlet side of the L:1 automatic pipe connection 1, while a single pipe is connected to an outlet side of the apparatus 1. Here, x stands for 1 or n, and n is a desired integer of 2 or greater. Through the respective pipes in the pipe group L_n, different fluids are supplied as described above.

[0019] Needless to say, the pipe group L_x can be controlled such that desired amounts of different fluids can be supplied in desired time zones to the pipes L₁-L_n, respectively.

[0020] M pipes are connected to an inlet side of the M:K automatic pipe connection 2, while K pipes are connected to an outlet side of the apparatus 2.

[0021] Each of the L:1 automatic pipe connection 1 and the M:K automatic pipe connection 2 has a unit with plural cells arranged in a row in a vertical plain and also

a unit with plural cells arranged in a row in a horizontal plain. Needless to say, selection can be made as desired as to which unit should be used in association with the inlet pipes or the outlet pipe(s).

[0022] A description will next be made about connections of the L:1 automatic pipe connection 1 and M:K automatic pipe connection 2. Incidentally, necessary control valves and the like are arranged on the inlet pipes L1-Ln of the L:1 automatic pipe connection 1, respectively.

[0023] The outlet pipe of the L:1 automatic pipe connection 1 is connected to one of the inlet pipes of the M:K automatic pipe connection 2 via a pipe 10. Accordingly, each fluid supplied to the L:1 automatic pipe connection 1 from the pipe group Lx is supplied to the inlet pipe of the M:K automatic pipe connection 2 via the pipe 10. To a top of desired one of process facilities A-D to be described in detail subsequently herein, this fluid can be supplied through the corresponding outlet pipe of the M:K automatic pipe connection.

[0024] Here, M is generally an integer of N+1 or greater. As mentioned above, the outlet pipe of the L:1 automatic pipe connection 1 is connected to the corresponding inlet pipe of the M:K automatic pipe connection 2. Since N is 4 in FIG. 1, M is 5. Although not illustrated in the drawing, a pipe such as a wash liquid feed pipe and another pipe to be used for other application may generally be needed as still further inlet pipes for the M:K automatic pipe connection 2. In essence, M indicates the number of pipes, which can be set freely as needed and is at least N+1.

[0025] K is generally a desired integer of N or greater. The outlet pipes of the M:K automatic pipe connection 2 may be required to include a pipe such as a wash liquid drainpipe. In essence, K indicates the number of pipes, which can be set freely as needed and is N or greater.

[0026] A description will next be made about the process facilities A-D. Needless to say, the number of process facilities in the present invention is not limited to 4 but may be greater or smaller than 4.

[0027] The process facilities A-D are of the batch type, and each of the process facilities is provided with a single outlet pipe extending from its bottom and also with a single inlet pipe arranged at its top. Here, N is an integer at least equal to the number of the process facilities A-D and in general, it is sufficient if the number of inlet pipes of the automatic pipe connection 1 is equal to the number of the process facilities.

Accordingly, N is 4 in the embodiment of FIG. 1.

[0028] Conventionally, such process facilities have each been provided with plural inlet pipes, control valves and the like. In the present invention, however, each of the process facilities A-D requires only one inlet pipe and moreover, this inlet pipe does not require any control valve, because the outlet pipe of the L:1 automatic pipe connection 1 is connected with the corresponding inlet pipe of the M:K automatic pipe connection 2 and each feed can be supplied to any desired one of the

process facilities A-D.

[0029] Pipes 20,22,24,26 as the above-described outlet pipes of the respective process facilities A-D are connected to the corresponding inlet pipes of the M:K automatic pipe connection 2, while pipes 21,23,25,27 as the above-described inlet pipes of the respective process facilities A-D are connected to the corresponding outlet pipes of the M:K automatic pipe connection 2.

[0030] As has been described above, the connection of the outlet pipe of the L:1 automatic pipe connection 1 to the corresponding one of the inlet pipes in the inlet pipe group of the M:K automatic pipe connection 2 has made it possible to supply each feed from the L:1 automatic pipe connection to desired one of the process facilities A-D via the M:K automatic pipe connection 2. As a consequence, a desired fluid, for example, a feed, a solvent, wash liquid, washing water or the like can be supplied to desired one of the process facilities A-D from desirably selected one of the pipes L1-Ln. As will be described in detail subsequently herein, it is possible to conduct, with extreme ease, operations such as internal washing of one of the process facilities with wash liquid or washing water supplied from the L:1 automatic pipe connection 1 via the M:K automatic pipe connection 2 so that, after a reaction product a obtained by conducting a reaction in the particular process facility is transferred to another desired one of the process facilities via the M:K automatic pipe connection 2, another reaction product b can be obtained in the same particular process facility or a different unit operation can be conducted there.

[0031] A description will hereinafter be made of functions which the process facilities A-D are equipped with.

[0032] A description will first be made about the case in which at least plural ones of the process facilities A-D has the same function. Needless to say, the term "has the same function" means that at least the plural process facilities can perform the same function. A description will hereinafter be made under an illustrative assumption that the process facilities A-C have the same function while the process facility D has a different function. These process facilities are not limited to so-called towers and/or tanks, but can be any facilities insofar as they are equipped with functions to permit unit operations.

[0033] As the process facilities A-D are of the batch type, they can be formed in, but not necessarily limited to, the same volume and/or the same configurations, and can be provided commonly with the same equipment, for example, with the plural devices of the same functions such as an agitator and distilling equipment. It is therefore possible to conduct either the same unit operation or different unit operations in the respective process facilities.

[0034] Secondly, a description will be made about the case in which at least plural ones of the process facilities A-C have different plural functions.

[0035] As in the first case, these plural process facil-

ities can perform the plural different functions. It is therefore possible to conduct the same unit operation or different unit operations in each of these process facilities.

[0036] Finally, in a case where each of the process facilities A-D has a single function different from those of the other process facilities, totally different unit operations are conducted in the respective process facilities.

[0037] A description will hereinafter be made of the feasibility of so-called small-lot variety production in an efficient manner. The description will be made under an illustrative assumption that reaction products a,b, both of which are pharmaceutical products, are to be produced.

[0038] In this production method, each of the reaction products a,b is obtained as a final product by forming it in a reaction step, collecting it in an extraction step, crystallizing it in a crystallization step, and then separating it in a centrifuge.

[0039] Feed pipes for those having liquid forms out of raw materials, reagents, solvent, wash liquid, washing water and the like for the reaction products a,b are connected to the pipes L1-Ln in the pipe group Lx. On the other hand, supply means for those having solid forms may be connected to desired ones of the process facilities A-D such that they can be supplied directly. In an example to be described hereinafter, out of the pipes L1-Ln in the pipe group Lx, the pipes L1,L2 are connected to the supply pipes for raw materials a1,a2 of the reaction product a, the pipes L3,L4 are connected to the supply pipes for raw materials b1,b2 of the reaction product b, and pipes L5,L6 are connected to the supply pipes for wash liquids a,b for the reaction products a,b, respectively.

[0040] A description will first be made about an illustrative case in which the process facilities A-C commonly have the same functions, that is, reacting function, extracting function and crystallizing function and the process facility D has a centrifugal separation function. This will equally apply to the cases to be described subsequently herein.

[0041] In this case, the raw materials a1,a2 or b1,b2 are supplied to one of the process facilities A-C, which has been selected as desired, and a reaction of the raw materials a1,a2 or b1,b2 and extraction and crystallization of the reaction product a or b are independently repeated in the corresponding process facilities A-C. The "reaction product a or b" obtained in the crystallization facility is separated by the centrifuge, whereby the "reaction product a" is obtained as desired. To avoid mixing of the other reaction product, it is preferred to provide two centrifuges, one exclusively for the "reaction product a" and the other for "the reaction product b".

[0042] The case in which the process facilities A-C have different plural functions will next be described under an illustrative assumption that the process facility A has reacting function and extracting function, the process facility B has extracting function and crystallizing function, and the process facility C has crystallizing

function and reacting function.

<Reaction in the process facility A; "reaction product a">

5 **[0043]** Through the pipes L1,L2, L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 21, the raw materials a1,a2 for the "reaction product a" are supplied to the process facility A, and in this process facility A, a reaction is conducted to obtain the "reaction product a".

10 **[0044]** The pipe 10 is then washed with "wash liquid b" supplied through the pipe L6 and L:1 automatic pipe connection 1. Washings are drained from the M:K automatic pipe connection through a drainpipe (not shown) arranged additionally, and are then subjected to further treatment.

<Reaction in the process facility C; "reaction product b">

20 **[0045]** After washing the pipe 10, the feed b1,b2 for the "reaction product b" are supplied to the process facility C through pipes L3,L4, L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 25, and a reaction is conducted to obtain the "reaction product b". <Move to extraction in the process facility A subsequent to the reaction in process facility A: "reaction product a">

25 **[0046]** Upon completion of the reaction in the process facility A, an extracting operation is then initiated in the process facility A.

30 <Transfer from the process facility C to the process facility B after completion of the reaction in the process facility C, and subsequent extraction in the process facility B; "reaction product b">

35 **[0047]** Subsequent to completion of a reaction in the process facility C, on the other hand, the reaction mixture is transferred from the process facility C to the process facility B through the pipe 24, the M:K automatic pipe connection 2 and the pipe 23, and extracting operation is then conducted in the process facility B. Upon completion of the transfer from the process facility C to the process facility B, the process facility C and the pipe 24 and M:K automatic pipe connection 2, which have been used for the transfer, are washed with "wash liquid b" supplied from the pipe L6 through the pipe 10, L:1 automatic pipe connection 1 and pipe 25. Incidentally, the resulting washings are drained from the M:K automatic pipe connection 2 through a drainpipe (not shown), and are then subjected to further treatment.

40 < Transfer of whole contents from the process facility B to the process facility C after completion of the extraction in the process facility B, and subsequent crystallization in the process facility C; "reaction product b">

45 **[0048]** The whole contents of the process facility B, in

which the above-described extracting operation has been completed, are transferred from the process facility B to the process facility C via the pipe 22, M:K automatic pipe connection 2 and pipe 25, and are then subjected to crystallization.

[0049] Upon completion of the transfer from the process facility B to the process facility C, the process facility B and the pipe 22 and M:K automatic pipe connection 2, which have been used for the transfer, are washed with wash liquid a supplied from the pipe L5 through the pipe 10, L:1 automatic pipe connection 1 and pipe 23. Incidentally, the resulting washings are drained from the M:K automatic pipe connection 2 through a drainpipe (not shown), and are then subjected to further treatment.

< Transfer of whole contents from the process facility A to the process facility B after completion of the extraction in the process facility A, and subsequent crystallization in the process facility B; "reaction product a">

[0050] The whole contents of the process facility A, in which the above-described extracting operation has been completed, are transferred from the process facility A to the process facility B via the pipe 20, M:K automatic pipe connection 2 and pipe 23, and are then subjected to crystallization.

[0051] Upon completion of the transfer from the process facility A to the process facility B, the process facility A and the pipe 20 and M:K automatic pipe connection 2, which have been used for the transfer, are washed with wash liquid a supplied from the pipe L6 through the pipe 10, L:1 automatic pipe connection 1 and pipe 21. Incidentally, the resulting washings are drained from the M:K automatic pipe connection 2 through a drainpipe (not shown), and are then subjected to further treatment.

< Transfer of whole contents from the process facility C to the process facility D subsequent to completion of the crystallization in the process facility C, and subsequent separation of the target product by a centrifuge; "reaction product b">

[0052] The whole contents of the process facility C are transferred to the process facility D through the pipe 24, M:K automatic pipe connection 2 and pipe 27. In the process facility D, the whole contents are washed with wash liquid b supplied through the pipe L6, L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 27. After that, the wash liquid b is centrifugally separated, and the thus-obtained crystals are then subjected to further treatment to obtain the target product ("reaction product b"). Incidentally, the resulting washings are supplied to the M:K automatic pipe connection 2 through the pipe 26, are drained from the M:K automatic pipe connection 2 through a drainpipe (not shown), and are then subjected to further treatment.

<Transfer of whole contents from the process facility B to the process facility D subsequent to completion of the crystallization in the process facility B, and subsequent separation of the target product by a centrifuge;

"reaction product a">

[0053] After the crystallization, the whole contents of the process facility B are transferred to the process facility D through the pipe 22, M:K automatic pipe connection 2 and pipe 27. In the process facility D, the whole contents are washed with wash liquid a supplied through the pipe 15, L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 27. To avoid contamination with the reaction product b, a centrifuge which is different from that used in connection with the "reaction product b" is used to separate the "wash liquid a". The thus-obtained crystals are then subjected to further treatment to obtain the target product (reaction product a). Incidentally, the resulting washings are supplied to the M:K automatic pipe connection 2 through the pipe 26, are drained from the M:K automatic pipe connection 2 through a drainpipe (not shown), and are then subjected to further treatment.

[0054] As has been described above, the reaction products a,b are obtained as final products through the following steps: the reaction product a: the process facility A (reaction) → the process facility A (extraction) → the process facility B (crystallization) → the process facility D (washing and separation) → the centrifuge (separation); the reaction product b: the process facility C (reaction) → the process facility B (extraction) → the process facility C (crystallization) → the process facility D (washing and separation) → the centrifuge (separation). In any one of these steps other than the washing and separation steps, one of the process facilities A-C remains unused. These process facilities A-C can be fully used without any unused period, for example, provided that the process facility C is used for a reaction while each of the process facilities A,B is used for the extraction.

[0055] By repeating these steps, the reaction product a,b can be produced while making full use of the process facilities A-C without any unused period.

[0056] Finally, a description will be made about a most common case, in which the process facilities A-D have different single functions, respectively, and reaction products a,b,a,b are obtained in this order. In this case, the process facilities A,B,C are assumed to have reacting function, extracting function and crystallizing function, respectively. Needless to say, as mentioned above, pipes and the like which have been used once are washed with wash liquid as needed, and the resulting washings are subjected to further treatment.

[0057] When it is desired to selectively obtain only one of the reaction products a,b, such washing can be omitted obviously.

[0058] As described above, the raw materials a1,a2 for the "reaction product a" are supplied to the process

facility A, followed by the initiation of their reaction. After completion of the reaction, the whole contents of the process facility A are transferred to the process facility B. Subsequently, the process facility A and transfer pipes and the like, including the pipe 10, are washed with the wash liquid b for the reaction product b as mentioned above.

[0059] Subsequent to the washing, the raw materials b1,b2 for the reaction product b are supplied to the process facility A, and their reaction is initiated.

[0060] In the process facility B, extraction is conducted. After the extracting operation, the whole contents are transferred to the process facility C. The process facility B and pipes and the like, including the pipe 10, are washed with the wash liquid b for the "reaction product b".

[0061] After the washing, the whole contents of the process facility A are transferred to the process facility B, and are then extracted. Here, the process facility A and transfer pipes, including the pipe 10, are washed with the wash liquid a for the reaction product a. The raw materials a1,a2 for the "reaction product a" are then supplied to the process facility A, and their reaction is initiated.

[0062] In the process facility C, crystallization of the "reaction product a" is conducted. Subsequent to completion of the crystallizing operation, the whole contents are transferred to the centrifuge to obtain the target product ("reaction product a"). The process facility A and transfer pipes and the like, including the pipe 10, are washed with the "wash liquid b" for the "reaction product b".

[0063] The whole contents of the process facility B are transferred to the process facility C, in which crystallization of the reaction product b is conducted. Subsequent to completion of the crystallizing operation, the whole contents are transferred to the centrifuge, and the target product (reaction product b) is obtained. The process facility C and transfer pipes and the like, including the pipe 10, are washed with the "wash liquid a" for the "reaction product a". Here, the process facility B and transfer pipes and the like, including the pipe 10, are washed with the "wash liquid a" for the "reaction product a", and the whole contents of the process facility A are transferred to the process facility B, in which extraction of the "reaction product a" is then conducted.

[0064] By repeating the above-described steps, the reaction product a and the reaction product b are obtained as final products in this order, so that the multi-product small-quantity production can be practiced efficiently. Further, substitution of the reaction product b for the reaction product a makes it possible to efficiently produce the same single product.

[0065] As has been described above, so-called small-lot variety production can be efficiently performed, and further, upon production of the same single product, it is possible to minimize unuse times of process facilities arranged in the same plant, in other words, to fully op-

erate the process facilities. As a consequence, the production per unit operation time can be increased, or the operation time required for the production of the same single product can be shortened.

[0066] The present invention will be described in further detail by examples. Needless to say, however, it should be borne in mind that the present invention is not limited to the examples to be described below.

10 Example 1

[0067] In general, methyl salicylate is obtained by charging salicylic acid, methanol and sulfuric acid into a reactor fitted with a reflux condenser and reacting them at 85°C to 90°C for 5 to 6 hours.

[0068] After completion of the reaction, unreacted methanol is recovered from the resulting reaction mixture. The reaction mixture is then cooled and is added with water to remove sulfuric acid. The reaction mixture is transferred to a washing tank, in which the reaction mixture is washed with a sodium carbonate solution and is hence deacidified. The deacidified reaction mixture is transferred to a drying tank, in which a drying agent is added to remove water. The reaction mixture so treated is then distilled in a distillation tower, whereby methyl salicylate is obtained. The above steps are known well.

[0069] Based on an illustrative case in which methyl salicylate is produced in accordance with the embodiment of FIG. 1, a description will be made about the possibility that upon production of the same single product, unuse times of process facilities arranged in the same plant can be minimized, in other words, the process facilities are operated fully and the production per unit operation time can be increased or the operation time required for the production of the same single product can be shortened.

[0070] In FIG. 1, the process facilities A-D have functions as a reaction vessel, a washing vessel, a drying vessel and a distillation tower, respectively, in the order of the signs.

[0071] In this example, the inlet pipes of the L:1 automatic pipe connection 1 are designated by L1-L4 and are connected to a methanol tank (not shown), a sulfuric acid tank (not shown), an aqueous sodium carbonate solution tank (not shown) and a water tank (not shown), respectively. Further, salicylic acid (not shown) and the drying agent (not shown) can be supplied to the process facilities A-C separately.

[0072] To the reaction vessel A, a predetermined amount of salicylic acid was supplied, and further, a predetermined amount of methanol and a predetermined amount of sulfuric acid were also supplied from the inlet pipes L1,L2, respectively, by way of the L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 21. Their reaction was initiated and was allowed to proceed at 90°C. Five hours after the initiation of the reaction, the reaction was terminated. Methanol was recovered by a condenser not shown in the

flow sheet. The recovered methanol was separately purified and was then recycled to the methanol tank.

[0073] On the other hand, water was supplied from the pipe L4 to the reaction vessel A. The whole contents (reaction mixture) of the reaction vessel A was transferred to the washing tank B through the pipe 20, M:K automatic pipe connection 2 and pipe 23.

[0074] To the reaction vessel A which had become empty, the above-mentioned predetermined amount of salicylic acid was supplied. Further, a predetermined amount of methanol and a predetermined amount of sulfuric acid were supplied from the inlet pipes L1, L2, respectively, through the L:1 automatic pipe connection 1, pipe 10, M:K automatic pipe connection 2 and pipe 21. In the reaction vessel A, their reaction was initiated and was allowed to proceed at 90°C for 5 hours.

[0075] On the other hand, the aqueous solution of sodium carbonate was supplied to the washing tank B, in which the sulfuric acid in the reaction mixture was then neutralized. Further, water was supplied to wash the neutralized reaction mixture. The resulting washings were delivered to the M:K automatic pipe connection 2 through the pipe 22. From the M:K automatic pipe connection 2, the washings were drained through a drainpipe (not shown) and were then subjected to further treatment.

[0076] The contents from which sulfuric acid had been removed were transferred to the drying tank C through the pipe 22, M:K automatic pipe connection 2 and pipe 25, and were then dried.

[0077] In the washing vessel B, operation similar to the above-mentioned operation was repeated.

[0078] The reaction mixture, which had been transferred to the drying vessel C and had been dried there, was transferred to the distillation tower D and was then distilled, whereby methyl salicylate was obtained.

[0079] In the washing vessel B, operation similar to the above-mentioned operation was repeated.

[0080] The above operations were repeated, and methyl salicylate was obtained efficiently.

[0081] According to the present invention, the following advantages can be brought about.

[0082] The connection of the outlet pipe of the L:1 automatic pipe connection to the corresponding inlet pipe of the M:K automatic pipe connection has made it possible to supply raw materials, a solvent, wash liquid and the like from the L:1 automatic pipe connection to desired process facility or facilities via the M:K automatic pipe connection. Accordingly, control valves or the like which have heretofore been needed for all the inlet pipes of process facilities can be omitted. It is now sufficient to provide only the inlet pipes of the L:1 automatic pipe connection with such control valves. Further, it is possible to plan multi-product small-quantity production irrespective of the number and available functions of process facilities and also to set a production schedule of the same single product such that unused periods of process facilities can be minimized.

Claims

1. An improved multi-purpose production system comprising:

a group of N batch process facilities each of which is provided with a single outlet pipe extending from a bottom thereof and also with a single inlet pipe extending from a top thereof, an M:K automatic pipe connection having M inlet pipes and K outlet pipes, and an L:1 automatic pipe connection having L inlet pipes and a single outlet pipe; wherein said N outlet pipes of said individual process facilities in said group and said N inlet pipes of said individual process facilities in said group are connected to desired ones of said inlet pipes and desired ones of outlet pipes of said M:K automatic pipe connection, respectively, and a remaining inlet pipe or desired one of remaining inlet pipes of said M:K automatic pipe connection and said single outlet pipe of said L:1 automatic pipe connection are connected together, in which L, K and M are desired integers indicating said numbers of said corresponding pipes, N stands for an integer indicating said number of said process facilities, $M \geq N+1$, and $K \geq N$.

2. A multi-purpose production system according to claim 1, wherein in said group of process facilities, plural process facilities have the same function.
3. A multi-purpose production system according to claim 1, wherein in said group of process facilities, plural process facilities have different plural functions.
4. A multi-purpose production system according to claim 1, wherein in said group of process facilities, said process facilities have different functions, respectively.
5. A multi-purpose production system according to claim 1, wherein only said L inlet pipes of said L:1 automatic pipe connection are provided with control valves, respectively.
6. An improved multi-purpose production method, which comprises:

using a multi-purpose production system as defined in any one of claims 1-5;
conducting a unit operation in one of said process facilities;
changing over said M:K automatic pipe connection to transfer contents of said one process fa-

cility to another one of said process facilities;
and conducting another unit operation in said
one process facility.

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FIG. 1

