|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Objective function | Or | |
| 2 | sale is given by |  |
| 3 | **The material purchase:** |  |
| 4 | **The material transportation** |  |
| 5 | **The carbon emission tax** |  |
| 6 | **The refinery operation of scenario n** |  |
| 7 | The inventory of scenario |  |
| 8 | **The product transportation of scenario n** |  |
| 9 | **The extra product purchase of scenario n** |  |
| 10 | The production surplus penalty of scenario |  |
| 11 | The production backlog penalty of scenario n |  |
| 12 | Material balance |  |
| 13 | **Product balance** |  |
| 14 | The product balance constraint at terminal |  |
| 15 | the product balance constraint at distribution base |  |
| 16 | **Sulfur content restriction** |  |
| 17 | **Procurement capacity limits** |  |
| 18 | the extra product procurement capacity |  |
| 19 | **Refinery operation** |  |
| 20 | **Inventory capacity upper limits** |  |
| 21 | **Capacity for mixed flows** |  |
| 22 | the logical relations of mixed flows at each node | , |
| 23 | **Product demands** |  |
| 24 | The upper bounds of each kind of product surplus or backlog |  |
| 25 | the constraints as follows give the logical relationship |  |
| 26 |  |  |

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| --- | --- |
| B | set of distribution bases indexed by b1, b2, b3 |
|  | penalty for production backlog per ton of product not being able to be produced at time period |
| C | set of domestic customers indexed by c1, c2, c3, c4, c5 |
|  | lower limit of operation capacity of refinery to process material at time period |
|  | upper limit of operation capacity of refinery to process material at time period |
|  | cost of production backlog penalty of scenario |
|  | cost of carbon emission tax of scenario |
|  | cost of extra product purchased of scenario |
|  | cost of inventory of scenario |
| Cmp | cost of material purchase |
| Cmtr | cost of material transportation |
|  | cost of product transportation of scenario |
|  | cost of refinery operation of scenario |

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| --- | --- |
|  | cost of production surplus penalty of scenario |
|  | demand for product of oversea customer at time period of scenario |
|  | demand for product of domestic customer at time period of scenario |
|  | distance between node and |
|  | desulfurization ratio of material at refinery |
| ECr | quantity of emitted per ton of material operated at refinery |
| EPPU | purchase upper limit of extra product at time period |
| E[profit] | expected profit |

|  |  |
| --- | --- |
|  | unit price of extra product purchased at terminal at time period |
|  | inventory upper limit of refinery for material at time period |
|  | inventory upper limit of terminal for product at time period |
|  | inventory upper limit of distribution base for product at time period |
|  | inventory unit price for material at refinery at time period |
|  | inventory unit price for product at terminal at time period |
|  | inventory unit price for product at distribution base at time period |
|  | are variables |
|  | set of materials indexed by |
|  |  |
|  | of unit price of material purchased at oil field at time period |
|  | unit price of material purchased at terminal at time period |
|  | unit price of transportation for material by transportation tool at time period |
|  | purchase upper limit of material at time period |
|  | flow of material from node to by transportation tool at time period |
|  | set of nodes in the supply chain model indexed by and ) |
|  | set of oversea customers indexed by oc1, oc2 |
| OF | set of oil field indexed by of |
|  | set of products indexed by |
|  | probability of scenario |
| PTUP | transportation unit price for product from node to by transportation tool at time period |
|  | unit price for product purchased at terminal at time period of scenario |
|  | unit price for product purchased at distribution at time period of scenario |
|  | flow of product from refinery to distribution by transportation tool at time period of scenario |
|  | flow of product from refinery to terminal by transportation tool at time period of scenario |
|  | flow of product from distribution to domestic customer by transportation tool at time period of scenario |
|  | flow of product from terminal to overseas customer by transportation tool at time period of scenario |
|  | flow of product from terminal to distribution by transportation tool at time period of scenario |
|  | flow of product from node to by transportation tool at time period |
|  | upper limit of backlog product needed by oversea customer at time period |
|  | upper limit of backlog product needed by domestic customer at time period |
|  | upper limit of surplus product to be purchased by domestic customer at time period |
|  | upper limit of surplus product to be purchased by oversea customer at time period |
|  | quantity of backlog product needed by customer at time period of scenario |
|  | quantity of backlog product needed by oversea customer at time period of scenario |
|  | quantity of extra product purchased at terminal to be sold at distribution at time period of scenario |
|  | quantity of extra product purchased at terminal to be sold onsite at time period of scenario |
|  | quantity of material operated by refinery at time period of scenario |
|  | quantity of material purchased at terminal by refinery at time period |
|  | quantity of material purchased at oil field of by refinery at time period |
|  | quantity of material stocked at refinery at time period of scenario |
|  | quantity of material transported from node to by transportation tool at time period |
|  | quantity of product produced by refinery sold at distribution at time period of scenario |
|  | quantity of product sold at terminal to overseas customer at time period of scenario |
|  | quantity of product sold at distribution to domestic customer at time period of scenario |
|  |  |
|  | quantity of product stocked at distribution at time period of scenario |
|  | quantity of product stocked at terminal at time period of scenario |
|  | quantity of product produced by refinery sold at terminal at time period of scenario |
|  | quantity of product transported by transportation tool from node to at time period of scenario |
|  | quantity of surplus product to be purchased by customer at time period of scenario |
|  | quantity of surplus product to be purchased by customer at time period of scenario |
|  | set of refineries indexed by |
|  | operation unit price for refinery to process material at time period |
| Sales | sales of scenario |
|  |  |
|  | set of scenarios indexed by |
|  | sulfur content of material at time period |
|  | sulfur content of product at time period |
|  | penalty for production surplus per ton of product produced at time period |
| TAXC | tax per ton of emitted |
|  | transportation upper limit from node to by transportation tool at time period |
|  |  |
|  | set of terminals indexed by |
|  | set of time periods indexed by 1, 2, 3 |
|  | set of transportation tools indexed by 1, |
|  | yield ratio of material to product at refinery |