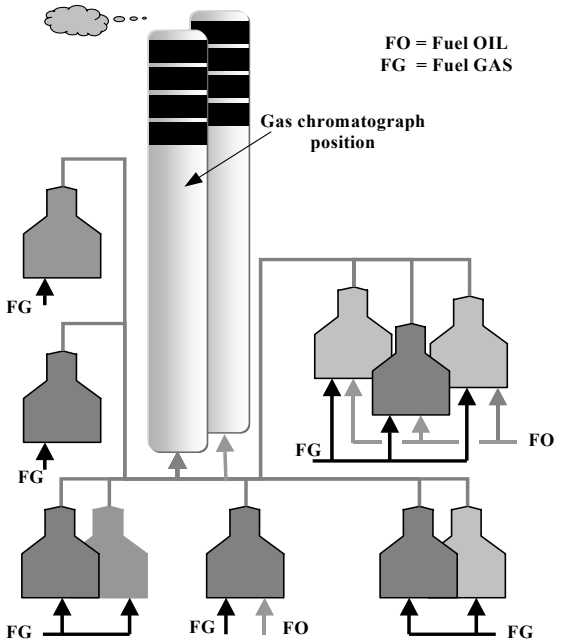

Figure A.1. A schematic view of chimneys used in the refinery to reduce the total amount of NO_x emission in the atmosphere. FG and FO from a number of refinery plants are burnt in reactors and the fumes obtained are conveyed to the chimneys. The arrow indicates the location of the on-line gas chromatograph used to acquire data on NO_x concentration.

Data considered in the design of soft sensors described here were obtained using records produced by the gas chromatograph during a period lasting about six months; they were collected in the plant database and used by plant operators for the estimation of mean monthly average emission values.

A.3 Debutanizer Column

The debutanizer column is part of a desulfuring and naphtha splitter plant, shown in Figure A.2, where two gray circles, A1 and A2, can be recognized. They represent the location of two gas chromatographs whose data were used to design soft sensors, while the two white circles, N1 and N2; indicate the points where soft sensors were required.

In particular, data acquired by the device A2, *i.e.*, the C4 (butane) content in the bottom flow to stock have been used in Chapter 6 as a study case for the design of the Soft Sensor named N2.

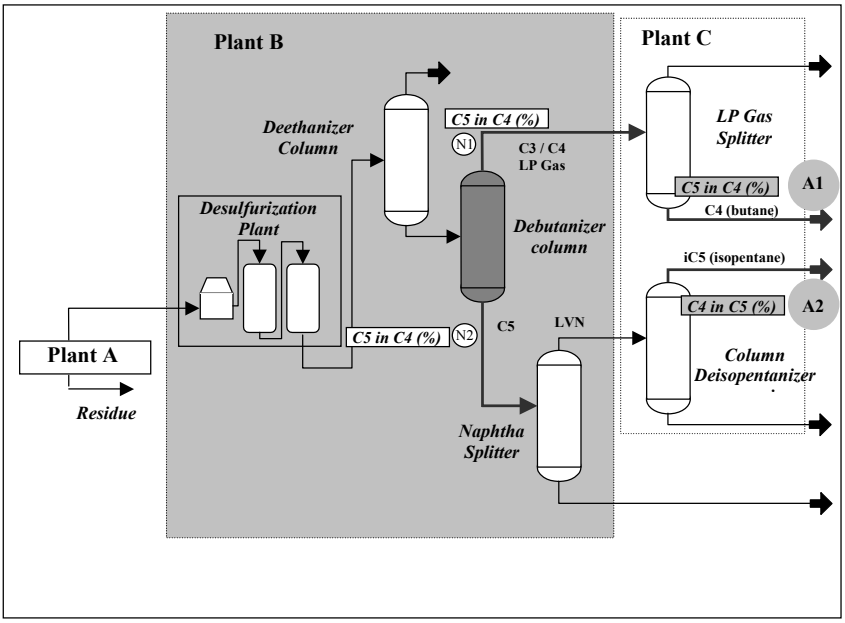

Figure A.2. Schematic view of the debutanizer column and connected plants. The location of two gas chromatographs (A1 and A2) is shown with two gray circles. N1 and N2 indicate the points where soft sensors were required

In the debutanizer column C3 (propane) and C4 (butane) are removed as overheads from the naphtha stream.

The debutanizer column is required to:

- ensure sufficient fractionation in the debutanizer;
- maximize the C5 (stabilized gasoline) content in the debutanizer overheads (LP gas splitter feed), while respecting the limit enforced by law;
- minimize the C4 (butane) content in the debutanizer bottoms (Naphtha splitter feed).

A detailed scheme of the debutanizer column is shown in Figure A.3.

A number of sensors, indicated with circles in Figure A.3, are installed on the plant to monitor product quality. The subset of sensors relevant to the application described, indicated with gray circles in Figure A.3, is listed in Table A.1, together with the corresponding description.

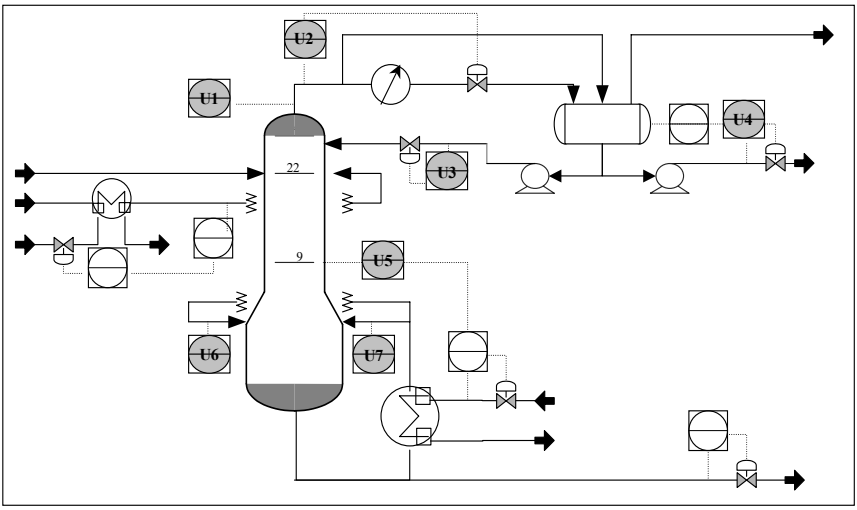

Figure A.3. Block scheme of the of the debutanizer column. Variables, as used in the case study described in Chapter 6, are indicated, along with the corresponding names, with gray circles. Open circles indicate variables, measured by instrumentation used by the refinery, but not used in the applications described

Table A.1. List of variables used in the design of soft sensors for the debutanizer column described in Chapter 6. Instrumentation location is reported in Figure A.3

Variable	Description
u_1	Top temperature
u_2	Top pressure
u_3	Reflux flow
u_4	Flow to next process
u_5	6^{th} tray temperature
u_6	Bottom temperature
u_7	Bottom temperature

The C4 content in the debutanizer bottoms, *i.e,* the Soft Sensor output, is measured on the overheads of the deisopentanizer column, as can be observed in Figure A.2, where the location of the measuring device is indicated by the gray circle named A2. It measures the C4 content in the flow to stock that can all assumed to be coming out of the debutanizer bottoms.