CLAIMS

1. A prediction model generation device for generating an exhaust gas concentration prediction model which predicts a concentration of a gas component contained in an exhaust gas discharged from a furnace, the prediction model generation device comprising:

an image acquisition unit configured to acquire an image of a combustion region of the furnace;

~~an extraction unit configured to convert the image into color image data and extract a feature from the color image data;~~

an extraction unit configured to convert the image into color image data divided the image into a plurality of color regions according to RGB values by clustering process and extract a total numbers of pixels of at least one color region of the plurality of color regions having a correlation of a predetermined value or more with the concentration of the gas component among the plurality of color regions as a feature from;

an exhaust gas concentration acquisition unit configured to acquire a concentration of the gas component contained in the exhaust gas, on a downstream side of the combustion region, after a preset time has elapsed from the time when the image has been captured; and

a model generation unit configured to generate the exhaust gas concentration prediction model by machine-learning training data in which the feature extracted by the extraction unit and the concentration of the gas component acquired by the exhaust gas concentration acquisition unit are associated with each other.

~~2. The prediction model generation device according to claim 1,~~

~~wherein the color image data includes dividing the image into a plurality of color regions according to color information by clustering process.~~

~~3. The prediction model generation device according to claim 2,~~

~~wherein the feature includes an area of at least one color region of the plurality of color~~

~~regions.~~

42. The prediction model generation device according to ~~any one of~~ claim~~s~~ 1 ~~to 3~~, further comprising a process data acquisition unit configured to acquire process data including at least one of a temperature in the furnace, a pressure in the furnace, or an amount of steam generated by combustion of fuel in the furnace,

wherein the model generation unit is configured to generate the exhaust gas concentration prediction model by machine-learning training data in which the feature extracted by the extraction unit, the concentration of the gas component acquired by the exhaust gas concentration acquisition unit, and the process data acquired by the process data acquired by the process data acquisition unit are associated with each other.

~~5~~3. The prediction model generation device according to claim ~~4~~2,

wherein the exhaust gas concentration acquisition unit is configured to further acquire an uncorrected concentration which is a concentration of the gas component contained in the exhaust gas at the time when the image is captured, and

wherein the model generation unit is configured to generate the exhaust gas concentration prediction model by machine-learning training data in which the feature extracted by the extraction unit, the uncorrected concentration and the concentration of the gas component acquired by the exhaust gas concentration acquisition unit, and the process data acquired by the process data acquisition unit are associated with each other.

~~6~~4. An exhaust gas concentration control system for controlling a concentration of a gas component contained in the exhaust gas discharged from the furnace, using the exhaust gas concentration prediction model generated by the prediction model generation device according to any one of claims 1 to ~~5~~3, the exhaust gas concentration control system comprising:

an imaging device configured to capture an image of the combustion region of the furnace; and

an adjustment device configured to adjust at least one of an amount of air supplied to the furnace or an amount of fuel supplied to the furnace, on the basis of a concentration of the gas component output by inputting a feature extracted from the image captured by the imaging device into the exhaust gas concentration prediction model.

~~7~~5. The exhaust gas concentration control system according to claim ~~6~~4,

wherein the gas component includes oxygen, and

wherein the adjustment device is configured to increase the amount of air supplied to the furnace when the concentration of oxygen output from the exhaust gas concentration prediction model is lower than a reference value of the adjustment device.

~~8~~6. The exhaust gas concentration control system according to claim ~~7~~5,

wherein the amount of air supplied to the furnace is determined according to a difference between the concentration of oxygen output from the exhaust gas concentration prediction model and a preset target value.

~~9~~7. The exhaust gas concentration control system according to claim ~~7~~5 or ~~8~~6,

wherein the adjustment device is configured to decrease the amount of air supplied to the furnace when the concentration of oxygen output from the exhaust gas concentration prediction model returns to the reference value of the adjustment device.

~~10~~8. The exhaust gas concentration control system according to any one of claims ~~6~~4 to ~~9~~7,

wherein the gas component includes oxygen, and

wherein the adjustment device is configured to decrease the amount of fuel supplied to the furnace when the concentration of oxygen output from the exhaust gas concentration prediction model is lower than a reference value of the adjustment device.

~~11~~9. A prediction model generation method for generating an exhaust gas concentration

prediction model which predicts a concentration of a gas component contained in an exhaust gas discharged from a furnace, the prediction model generation method comprising:

a step of acquiring an image of a combustion region of the furnace;

~~a step of converting the image into color image data and extracting a feature from the color image data;~~

a step of converting the image into color image data divided the image into a plurality of color regions according to RGB values by clustering process and extracting a total numbers of pixels of at least one color region of the plurality of color regions having a correlation of a predetermined value or more with the concentration of the gas component among the plurality of color regions as a feature from;

a step of acquiring a concentration of the gas component contained in the exhaust gas, on a downstream side of the combustion region, after a preset time has elapsed from the time when the image has been captured; and

a step of generating the exhaust gas concentration prediction model by machine-learning training data in which the feature and the concentration of the gas component contained in the exhaust gas after the preset time has elapsed from the time when the image has been captured are associated with each other.

~~12~~10.An exhaust gas concentration control method for controlling a concentration of a gas component contained in the exhaust gas discharged from the furnace, using the exhaust gas concentration prediction model generated by the prediction model generation method according to claim ~~11~~9, the exhaust gas concentration control method comprising:

an imaging step of capturing an image of the combustion region of the furnace; and

an adjustment step of adjusting at least one of an amount of air supplied to the furnace or an amount of fuel supplied to the furnace, on the basis of a concentration of the gas component output by inputting a feature extracted from the image captured in the imaging step into the exhaust gas concentration prediction model.